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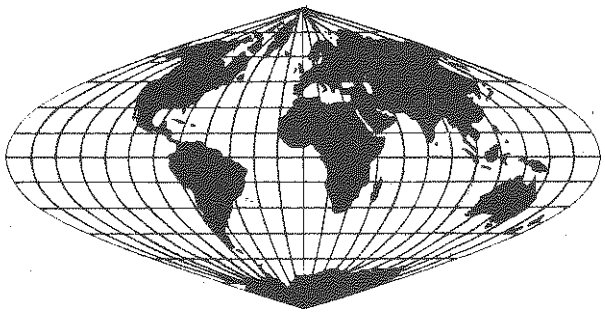
CORNELL/INTERNATIONAL AGRICULTURAL ECONOMICS STUDY

THE DEMAND FOR LIVESTOCK FEED IN THAILAND

Merritt Chesley



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Economic development is invariably accompanied by dietary change. As people become wealthier, their direct consumption of the starchy staple foods--wheat, rice, maize and the edible roots--declines and is replaced by more preferred items, especially meat. This change becomes most pronounced when per capita incomes reach the $500-$800 range. This onset of middle-income status has recently been attained in a number of countries and it behooves us to better understand its implications for the demand for feedstuffs. Such is the subject of Merritt Chesley's study of Thailand.

Thailand has long been a major rice exporter and during the past several decades has become an important supplier of feedstuffs to Japan and the EEC. These sectors of the agricultural economy are well documented. The emergence of the domestic livestock industry, on the other hand, has been so recent that it has outpaced development of the statistical reporting system. Gaps in the evidence abound, as do conflicts between one source and another. Much of Ms. Chesley's paper is therefore given over to a careful weighing and sifting of the data.

Comparing evidence from various sources, Ms. Chesley first estimates current livestock production, both on small farms and in commercial operations. She then projects a range to 1990 for future feed demand by using estimated income elasticities, expected growth rates of population and income, and feed conversion rates.

When this demand is balanced against feed supply, it can be seen that Thailand produces a surplus of energy feed ingredients and will be able to supply even a high growth in demand. Rice milling by-products are still the major feeds used, but average annual growth in production is moderate. A large rise in demand may thus necessitate further domestic use of maize, most of which is still exported. Supply of protein feeds, however, will most likely continue to be dependent upon imports.

Much of the information was gathered by Ms. Chesley during a three-month visit to Thailand in 1983 and it is appropriate to acknowledge the assistance so cordially extended her. Particularly helpful were: Chamnien Boonma, Boonjit Titapiwatanakun, Orachorn Attiveerakul, and Aphiphan Pookpakdi of Kasetsart University; Theodore Panayotou of the Agricultural Development Council; Phongthep Chiaravanont and Adnan Aydin

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At Cornell, special thanks are due John Dyck and Lillian Thomas. Professor K. L. Robinson shared with me the satisfaction of working with Ms. Chesley.

Comments are welcome and these should be addressed to:

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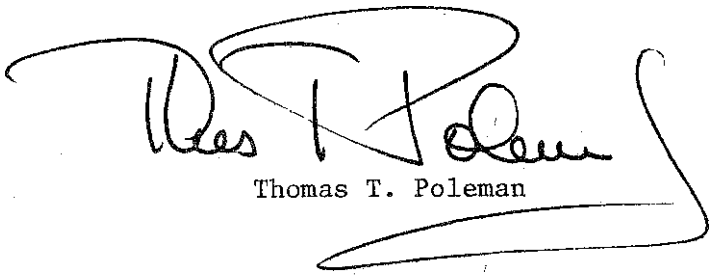

Thomas T. Poleman

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Chapter I

INTRODUCTION

Economic development in Thailand has affected the livestock sub-sector from two directions. On the supply side, technological change and increasing specialization have changed the structure of production processes and have reduced production costs. On the demand side, higher incomes have induced higher meat consumption both in absolute terms and as a percent of overall food consumption. Consequently, livestock production has grown appreciably in the past two decades.

The objectives of this paper are to explore the changing situation for feed and livestock production in Thailand, to estimate current demand for feed, and to project future demand for feed. Data were collected in Thailand during the summer of 1983 from government ministries, university researchers, and feed companies.

Rich in resources and blessed with a high land-man ratio, Thailand has always been a food-surplus country. The only country in Southeast Asia to have successfully avoided colonization, Thailand has been able to chart a relatively independent course, and the government intervenes minimally in the economy.

Since 1960, the economy has grown at a striking rate. The average annual growth rate in real GDP was 8.4% in the 1960s and 7.2% in the 1970s (83). These growth rates were larger than the growth rate averages for any of the country categories classified by the World Bank, including oil exporters and industrial market economies. This strong economic development has brought with it extensive changes in the structure of the economy and in livestock production systems.

Until the 1970s, livestock production in Thailand was purely a sideline of small-farm crop production. Ruminants (cattle and water buffalo) were kept solely for draft purposes; swine and poultry were raised incidentally as a low-cost means to provide additional farm income. Feeds were residual: ruminants were grazed, swine were fed by-products from rice milling, and poultry scavenged from farm wastes.

In a very short time, however, imported technology and increased meat demand have encouraged a trend toward specialization in some types of livestock production. The majority of chickens are now raised commercially on specialized farms. Swine production is in a transitional phase; commercial operations have increased, but the trend toward specialization is restricted by government regulations regarding slaughter. Ruminants continue to be maintained primarily for their uses in crop production.

These changes, primarily in chicken production and secondarily in hog production, have had a large impact upon the Thai feed economy. The prodigious supply response of Thai farmers is now legendary, and Thailand has become a major exporter of many agricultural items. Feed production is a principal component of crop production; maize and cassava, both produced as feedstuffs, are the two most important crops after rice in terms of area planted. The phenomenal growth in production of these feeds in the 1960s and 1970s, however, resulted solely from a strong export demand. Only in the 1970s did the expanding commercialization of chicken production lead to considerable amounts of maize being used domestically.

How the livestock sector develops, then, will have a profound effect upon the future production and utilization of major Thai crops. Secondary issues involved in an investigation of feed demand include future domestic utilization of maize; potential domestic utilization of cassava in the face of a constricting export market; the increasing need to import protein feeds; and the role of the commercial feed industry.

In Chapter II, the major energy and protein feeds produced in Thailand are discussed and current feed supply is defined. The shifting production processes in the livestock sector are described in Chapter III, and the number of feed-consuming livestock now produced are estimated. Then, in Chapter IV, these numbers are used to assess current feed demand and to project future feed demand. In Chapter IV, prospects for supply and demand are brought together and the implications for policy are reviewed.

Chapter II

FEED SUPPLY

> Since what is considered feed, as opposed to human food or just plain waste, changes with economic conditions, it is difficult to assess a country's feed supply at any given time.
>
> —William T. Coyle, "Japan's Feed-Livestock Economy" (Washington, D.C.: USDA, February 1983).

Unfortunately, evaluating the feed supply situation is especially problematic in a country like Thailand, where much of the crop production (whether for food or feed) is for subsistence consumption and therefore not marketed, where ruminant animals subsist almost wholly by grazing, and where waste materials (crop residues, bagasse) can be a large part of animal diets. Estimates based on feed crop production are likely to represent a minimum level of actual feed available and consumed.

Thailand is self-sufficient in energy feeds, and exports a large amount of the feeds produced, of which the most important are rice products, maize and cassava. Grain sorghum is another feed grown in Thailand, but it is a minor crop, as less than 400,000 tons are produced annually, and only about 30 percent of that is consumed within the country (79, p. 18). Feed production, in fact, plays a significant role in Thai agriculture, for maize and cassava are the two most important crops after rice, in terms of both acreage planted and export revenues. Only rice products and maize are used domestically for feed, however, and the domestic use of maize is of recent origin.

Rice Products

Thailand has been an important supplier of rice for centuries. The treaties imposed upon the Kingdom by the Western powers in the second half of the nineteenth century reduced tariffs on goods imported into Thailand to very low levels and consequently opened up the Thai market to foreign goods. This made the growing and export of rice more profitable, and intensified the country's dependence upon rice production and trade (23).

Rice is still by far the most important crop; the area planted to rice is more than twice the area planted to all other crops.[1] Rice is grown throughout Thailand, by almost every Thai farmer, and is milled locally. The by-products of the milling process, which are used as animal feed, are thus readily available to livestock producers in all parts of the country.

Rice products as feed

The rice products used in animal feeding are broken rice and rice bran. Broken rice is simply milled, polished rice that was broken during the milling process and comprises up to 17 percent of the weight of unmilled paddy, depending on the milling technology (30, p. 333). It is either sold as low-quality rice for human consumption, used for manufacturing noodles, or fed to animals. Rice bran, which is approximately ten percent of paddy and contains most of the vitamins and protein of the rice grain, consists of the seed coat and germ which are removed from the grain after hulling. In removing the bran, brown rice becomes white rice.

In Thailand, two kinds of bran, coarse and fine, are differentiated. Coarse bran refers to outer layers which are removed at an early milling stage and which are not very high in nutritional value. Fine bran is removed from the grain at the next stage and is more valuable. Fine bran contains 14-19 percent oil (30, p. 335; 36, p. 190) and must therefore be used within several days of milling or it will become rancid. In addition to its use as animal feed, fine bran is used in the vegetable oil industry: the resultant bran cake (also called bran meal or defatted bran), which is left after oil extraction, is fairly high in protein and is also used as feed.

The nutritional characteristics of the rice products discussed above are compared with maize in Table 2.1. Although the reported chemical composition of each of the products varies with different locations as well as with different researchers, one can see that broken rice (which has, of course, the same nutrient value as whole grain rice) is higher than maize in digestible carbohydrates but lower in protein. Rice bran, which contains about 84 percent of the total digestible nutrients of maize (33, p. 286), is a nutritional complement to maize: it contains considerably more protein, fiber, fat and mineral matter, but is lower in carbohydrates. Rice bran cake, with the oil removed, has very little fat and the highest concentration of protein.

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[1] Agricultural statistics in this paper not otherwise referenced are obtained from the annual Agricultural Statistics of Thailand published by the Ministry of Agriculture and Cooperatives (MOAC).

TABLE 2.1

NUTRITIONAL COMPARISON OF RICE PRODUCTS AND MAIZE

	Percent Dry Matter	As Percent of Dry Matter				
		Protein	Fiber	Fat	NFE[a]	Ash[b]
Maize[c] (yellow, shelled)	86.0	8.8	2.0	3.8	70.3	1.1
Broken rice[d] (Iraq)	87.5	7.9	1.8	1.8	87.1	1.4
Broken rice[d] (Nigeria)	90.1	9.1	0.3	0.1	89.9	0.6
Broken rice[e]	88.0	6.7	0.3	0.4	80.4	0.5
Rice bran[c]	90.7	13.0	11.2	14.4	40.1	12.1
Rice bran[d] (Philippines)	88.8	10.6	18.9	10.6	46.1	13.8
Rice bran[d] (Iraq)	91.1	12.4	10.2	18.3	46.3	12.8
Rice bran[f]	90.0	13.0	9.0	19.0	41.0	8.0
Rice bran cake[e]	100.0	10.6	11.4	0.9	—	7.4
Rice bran cake[e]	100.0	10.4	11.1	0.7	—	7.9
Rice bran cake[f]	90.0	16.0	11.0	0.5	52.0	10.0

a. Nitrogen-Free Extract, a measure of digestible carbohydrates.
b. Mineral matter.
c. Source: A.E. Cullison, Feeds and Feeding (Reston, 1982), pp. 562, 570.
d. Source: B. Goehl, Tropical Feeds (Rome, 1981), p. 336.
e. Source: D.F. Houston, Rice Chemistry and Technology (St. Paul, 1972), pp. 28, 276.
f. Source: N.L. Kent, Technology of Cereals (Oxford, 1983), p. 191.

Broken rice, then, is a fairly close nutritional substitute for maize, and is used in both swine and poultry rations in Thailand. Fine bran, with its high fiber content, is used more for fattening pigs, while coarse bran is used primarily in duck and dairy cattle feeds (75).

Supply of rice products

The localized nature of milling operations in Thailand makes it impossible to properly ascertain the quantities of rice products available for use as animal feed. The supply figures given in Table 2.2 were derived with the aid of several assumptions which are spelled out below.

According to Tim[2] (75), 8.6 percent of the paddy is broken rice which is not used for human consumption, and virtually all of this (99 percent) is used domestically for feed. This means that about half of the rice[3] which is broken during milling is used for feed; the rest is mixed with whole rice grains and sold as lower-grade rice, or manufactured into noodles. Tim also gives estimates of 6.8 percent and 3.2 percent for the amount of paddy which is removed as fine bran and coarse bran, respectively. The National Economic and Social Development Board (NESDB) gives similar estimates of 8.6 percent for broken rice, 6.5 percent for fine bran, and 3.0 percent for coarse bran (73).

There are no data available regarding current usage of rice bran in the vegetable oil industry. Such figures, if available, would indicate production of rice bran cake. However, it presumably is not significant: in 1975, only three to five percent of the rice bran produced went into oil production; the rest was used as feed (41, p. 27).

Virtually all of these by-products are used within Thailand. Exports of both rice bran and rice bran cake have been controlled since 1947 and are not significant. The rapid deterioration of bran also inhibits its trade. Appendix Table 1 provides trade data for

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[2] Contrary to Western custom, Thai people are commonly referred to by their first names, a practice which is followed throughout this paper for any Thai references. Tim Bhannasiri is director of the Department of Livestock Development (DLD); many of the assumptions used in this section to derive feed supply of rice products are based on his figures.

[3] The 17 percent figure given by Goehl (30) as a high level of grain breakage is probably a safe representation of the Thai milling situation, since the USDA estimates that, even with the efficient milling practices in the U.S., 15 percent of the rice milled is broken (21, p. 264).

TABLE 2.2

THAILAND: SUPPLY OF RICE FEED INGREDIENTS, 1970/71-1982/83

(1000 tons)

Cropyear	Unmilled Paddy Production[a]	Broken Rice[b]	Bran		Total Supply of Rice Feed Ingredients
			Fine[c]	Coarse[d]	
1970/71	13,570	1,167	923	434	2,524
1971/72	13,744	1,182	935	440	2,556
1972/73	12,413	1,068	912	397	2,377
1973/74	14,899	1,281	1,013	477	2,771
1974/75	13,386	1,151	910	428	2,490
1975/76	15,300	1,316	1,040	490	2,846
1976/77	15,068	1,296	1,025	482	2,803
1977/78	13,921	1,197	947	445	2,589
1978/79	17,470	1,502	1,188	559	3,249
1979/80	15,758	1,355	1,072	504	2,931
1980/81	17,774	1,529	1,209	569	3,306
1981/82	18,750[e]	1,613	1,275	600	3,488
1982/83	17,250[e]	1,484	1,173	552	3,209

SOURCES:

a. Thailand, MOAC, Agricultural Statistics of Thailand, various issues.
b. Assumes 8.6% of paddy production.
c. Assumes 6.8% of paddy production (includes bran cake).
d. Assumes 3.2% of paddy production.
e. USDA, FAS/Bangkok estimates.

bran and bran cake. The greatest volume of exports occurred in 1972, when export controls were temporarily relaxed (41) and a net equivalent of 40,000 tons (four times the volume of any other year) of rice bran were exported; this, however, was less than five percent of total bran production.

Future prospects

Thai rice production provides a little more than 3 million tons of by-products annually for livestock feed. About half of this is in the form of broken rice; fine bran provides about 1 million tons per year, and coarse bran makes up the rest. Supply of these rice products exhibited a moderate annual growth rate of 2.5 percent from 1970/71 to 1982/83. Recent trends can be expected to continue.

Some further increase in paddy production is likely, due to expanded planted area allowed by irrigation advances and to higher yields promoted by increased use of improved inputs. However, the amount of broken rice and bran available for livestock feed may not increase; as more efficient milling technology is adopted, the yield of rice by-products is reduced. If controls on exports of bran and bran cake were to be relaxed in the future, domestic availability could conceivably be affected. Exports of bran, however, would still be limited by the risks of rancidity; and exports of bran cake are contingent upon its production, which ultimately depends upon the demand for bran by the vegetable oil industry and its price substitutability with oilseeds.

Agricultural diversification

Rice has been the main crop and primary export item for more than 150 years. In the past thirty years, however, the agricultural sector has become more diverse. From 1950 to 1980, although the amount of paddy land increased by 50 percent, rice land as a proportion of all farm land dropped from 90 percent to 62 percent. Similarly, although exports of rice and rice products (including flour and noodles) doubled in the same period, their share in the value of all agricultural exports (including forestry and fishery items) decreased from more than half to one-quarter.

This diversification can be traced to several factors. Of major importance was the "rice premium", a tax on rice exports which was established after World War II and acted to hold down the domestic price of rice. Because rice is the principal food staple, this has kept the general cost of living down. In addition, lower rice prices made rice less attractive for farmers to grow and encouraged

production of other crops.[4] An efficient marketing and distribution system (already established because of Thailand's long history in the rice trade), combined with extensive post-war improvements in transportation and infrastructure, made it possible to take advantage of a booming export demand for other cash crops.

Maize

Maize was a minor Thai crop for several hundred years, and only began to be of interest commercially after 1951, when yellow flint maize was introduced by USAID advisors. The development of this variety was part of an aid program targeted toward the Northeast. In the late 1950s, however, production in the Central Plain overtook that of the Northeast (52; 59). Today, Thailand produces more than three million tons of maize annually, 50 percent or more of which is concentrated in four of the central provinces. (See Map 2.1.)

Starting in the late 1950s and continuing through the 1960s and 1970s, maize production shot up phenomenally in response to Japanese demand for animal feed to support its burgeoning livestock industry. Part of this new production came about as cotton and soybean producers in central Thailand, faced with declining commodity prices, shifted into more profitable maize production. In addition, maize was planted on new land that was able to be cleared in the upper Central Plain as malaria was brought under better control. Improved transport systems also made it possible to move maize to ports (62).

In a mere two decades, then, effective supply response both transformed maize into one of Thailand's major crops and made Thailand into one the world's leading maize exporters. The area harvested increased sixfold, from less than 0.3 million hectares in 1960 to 1.7 million hectares in 1982, making it second only to rice in terms of planted area. By comparison, rice hectarage during this period increased by only 63 percent. The trends in area devoted to these two crops are shown in Figure 2.1. The value of maize exports also rose during this time by 400 percent, from about 0.6 million baht[5] in 1960 to 2.3 billion baht (in constant terms) in 1981. At that time it provided almost a tenth of the value of all agricultural exports.

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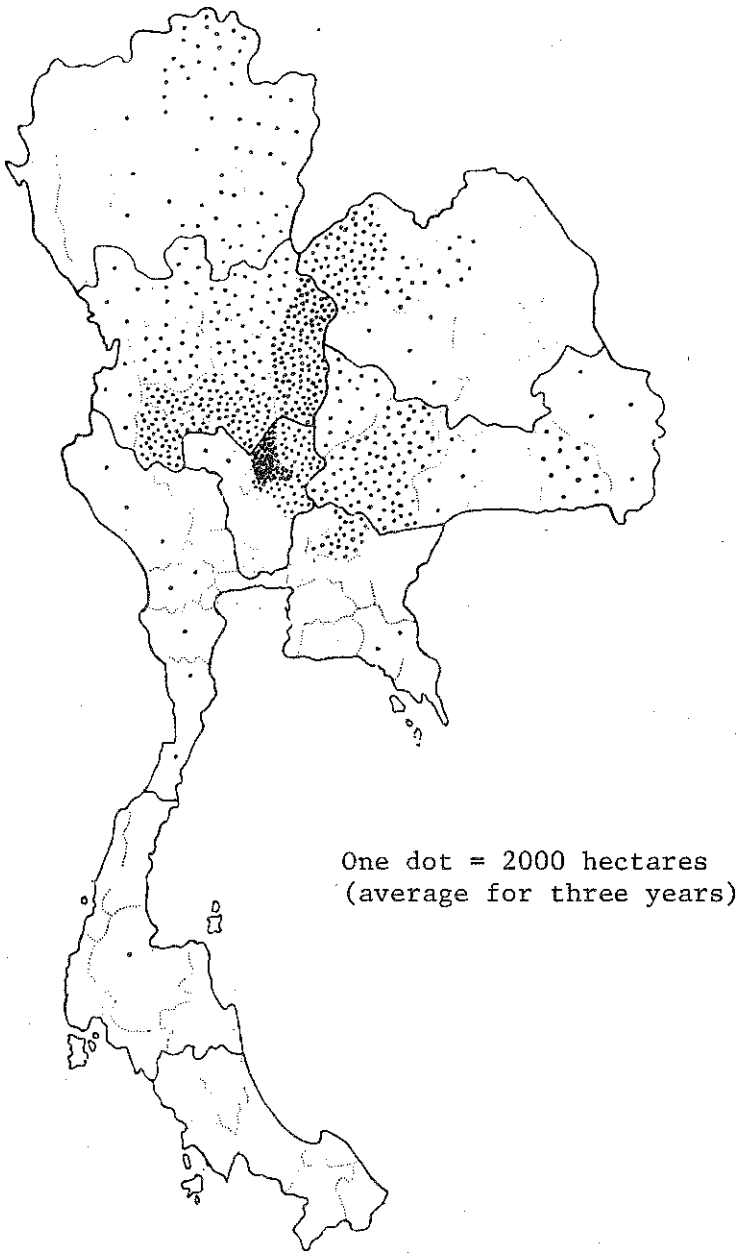
[4] Silcock (59) gives a fascinating account of the political and economic factors during and after the war which led to the taxation of rice exports, and elaborates on its effects upon the Thai economy.

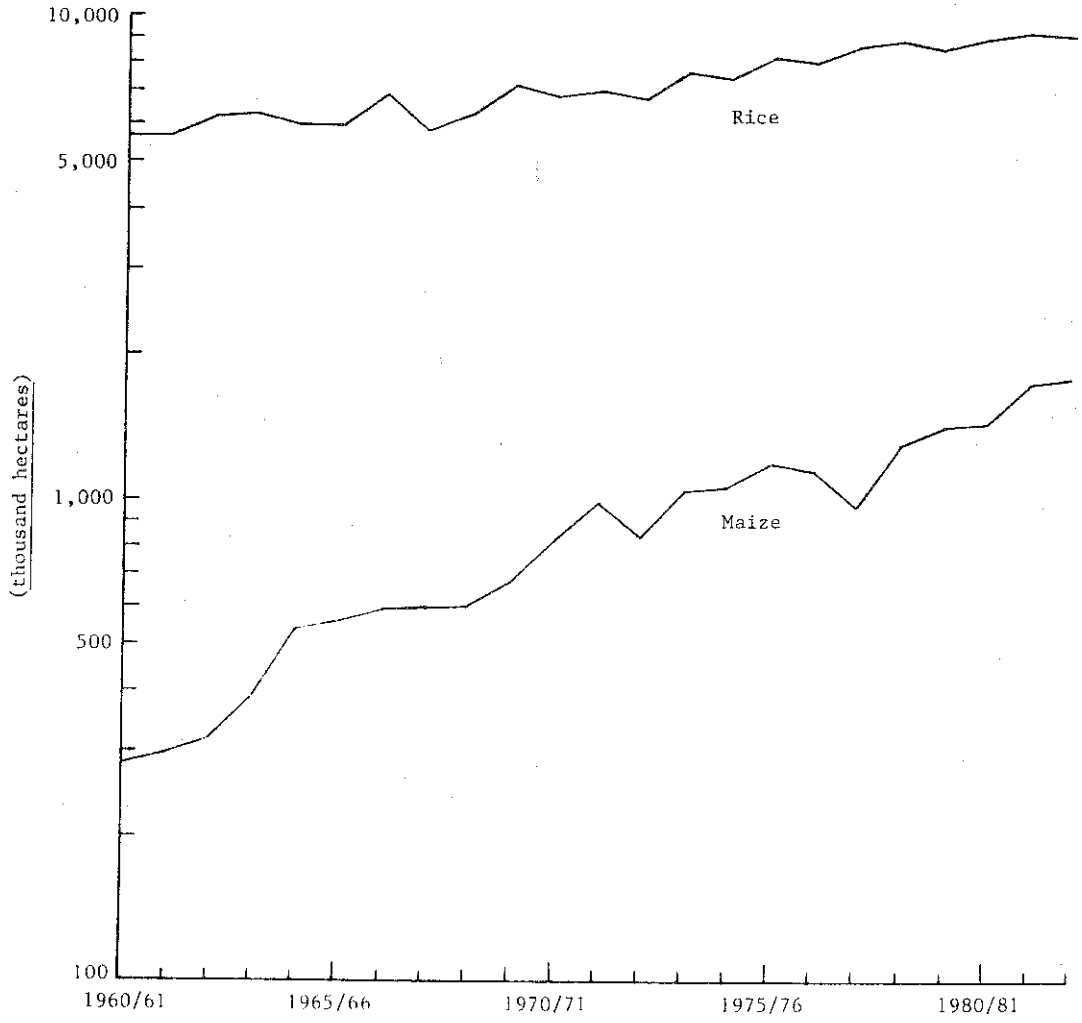
[5] From 1967-1980, there were about 20.5 baht in U.S. $1.00. By 1983, the exchange rate had fallen to about 23.0 baht per U.S. $1.00.

Map 2.1: THAILAND: GEOGRAPHICAL DISTRIBUTION OF MAIZE PRODUCTION, AVERAGE 1979/80-1981/82



Source: Thailand, MOAC, Agricultural Statistics of Thailand, Crop Year 1981/82, p. 26.

Figure 2.1: THAILAND: RICE AND MAIZE, AREA HARVESTED, 1960/61-1982/83



Source: Data supplied by Ministry of Agriculture and Cooperatives. Data for cropyears 1981/82 and 1982/83 are USDA, FAS/Bangkok estimates.

Export trade

With an export industry characterized by many small firms and such rapid growth, the resultant chaotic market conditions in the early years led to contracts being broken by both sides. This stimulated the Thai government to introduce more regulation into the maize trade. The eventual structure of the maize export trade was formulated in 1962 when Thailand secured an agreement with its largest customer, Japan. This agreement between the Thai government and private Japanese importers arranged for monthly determination of prices and quantities to be exported to Japan. A similar agreement was later concluded with Taiwan, which became the second largest importer in the late 1960s. In addition, the Thai government introduced export quotas for other countries to facilitate marketing flows.

The pricing provisions of the Thai-Japanese agreements, which were renegotiated annually, were modified over the years until 1966, when it was established that the buying price would be determined by the price of U.S. #2 yellow corn based on the Chicago futures market.[6] This pricing mechanism indicates the fact that, although Thailand is the fifth largest maize exporter in the world, the U.S. so dominates the market (it usually accounts for about three-fourths of the world trade in maize) that a small country like Thailand (making up 3 percent or less of the maize trade) is in the position of price-taker.

In the last ten years, the export market has changed considerably. For a variety of reasons,[7] both Japan and Taiwan have sharply curtailed their imports from Thailand. Exports to the two countries averaged 70 percent of total Thai maize trade during the 1960s, but dropped to an average of 15 percent in 1979-81. (See Figure 2.2.) At the same time, the oil-rich Arab nations, with expanding livestock industries, have become a significant market; their share of Thai exports increased from four percent in 1975 to 34 percent in 1982.

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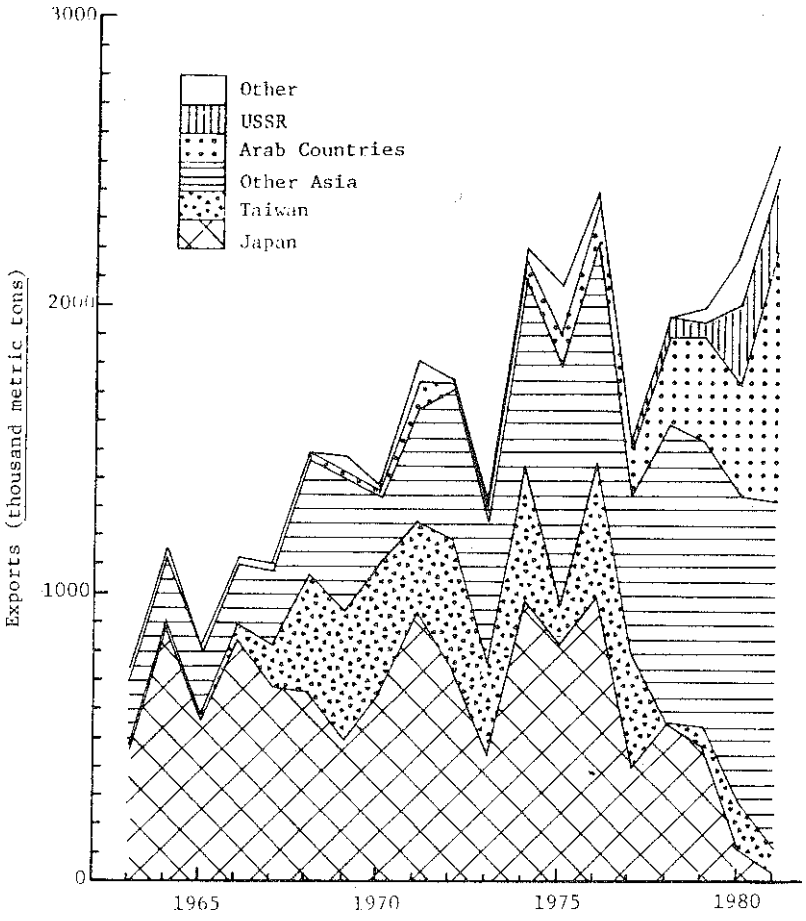
[6] An average was taken of the Chicago futures closing quotations during the thirty days preceding the monthly price-fixing date, excluding the three highest and three lowest quotations during this period. For a clear explanation of the intricacies of price determination, quantity allotments, and shipping schedules under these agreements, see Goldberg and McGinity (31, pp. 118-128). Chaiwat (9) gives a good summary of the historical development of the agreements.

[7] The primary reasons are the presence of the carcinogen aflatoxin in Thai maize, and the higher relative shipping costs necessitated by the smaller vessels needed to navigate the Chao Phraya River.

Figure 2.2: THAILAND: MAIZE EXPORTS, 1963-1981



Source: Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.

Domestic use

Another major change in the Thai maize marketing system is the increasing amount used domestically. The dramatic growth in maize production was export-led; throughout the 1960s domestic maize use averaged less than four percent of total production. With the development of the animal feed industry in the early 1970s, however, domestic demand for maize increased, to the point that a third of total production is now used for domestic feed.

The increasing proportion of maize going into the domestic market can be seen from Table 2.3 and Figure 2.3. Although small amounts of maize are consumed directly as food, the increases are due almost wholly to expanded consumption as feed. Thus, consumption of maize as feed, which was only one-fifth of total domestic utilization in 1960, now accounts for 97 percent of total utilization.

The growth of the commercial feed industry was the major factor in the rise in domestic use of maize. This is the result of maize's nutritional qualities and its price competitiveness with rice. (See Figure 2.4.) In addition, the centralized, export-oriented maize marketing system makes maize easily accessible to the centrally-located feed industry. Maize accounts for 40-65 percent of the total ingredients used by feed manufacturers (34). The synchronous rise in commercial feed production and the increased domestic use of maize can be seen in Figure 2.5.

As in many other countries with infant feed and livestock industries, the poultry sector led much of the growth in the Thai industry; since 1970, broiler and layer feeds have accounted for 64-70 percent of total commercial feed production (41; 72; 5). This has additional significance for the use of maize, because, in addition to its superior nutritional qualities, maize is typically preferred for chicken feed because of the yellowish color it imparts to the meat.

Future prospects

A major obstacle facing future expansion of Thai maize is the purely extensive nature of its growth in the past twenty-five years. Thailand's traditionally low land-man ratio made cropland expansion a viable means to increase production of many crops, but after thirty years of radical cropland extension, new land is increasingly marginal and problems of deforestation are becoming severe.

Future growth will have to come from increasing yields, which are low and thus have much potential for improvement. Average yields increased from 1.0 ton per hectare in the early 1950s to 1.9 ton per hectare in the early 1960s, but have not risen significantly since then.

TABLE 2.3

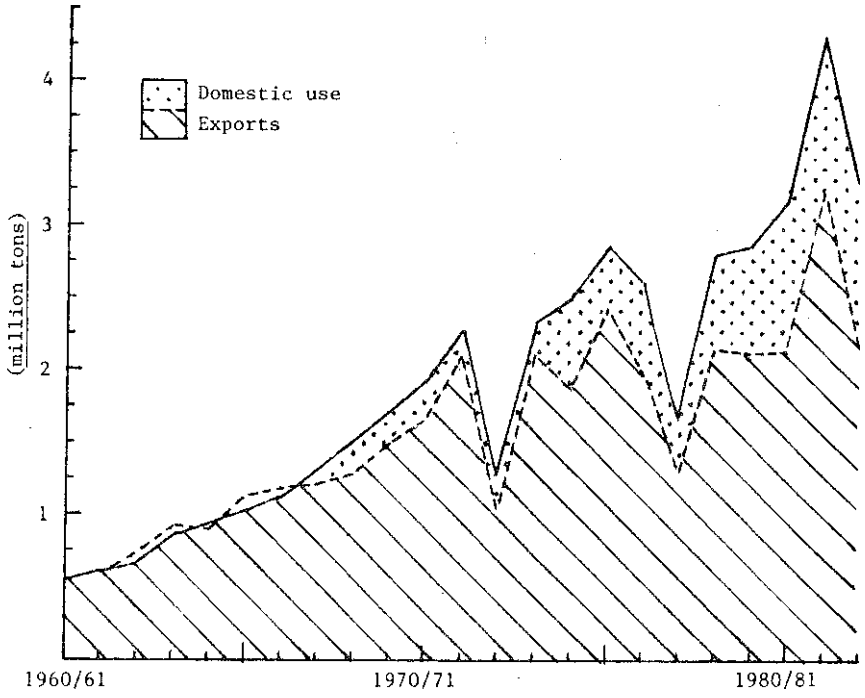
THAILAND: MAIZE PRODUCTION AND UTILIZATION, 1960/61-1982/83

Cropyear[a]	Total[b] Production	Exports	Domestic Use	Feed Use	Domestic Use as % of Total Production	Feed Use As % of Domestic Use
	(1000 tons)					
1960/61	544	519	10	2	2	20
1961/62	598	589	15	4	3	27
1962/63	665	722	15	4	2	27
1963/64	858	923	20	6	2	30
1964/65	935	896	25	10	3	40
1965/66	1021	1132	29	10	3	34
1966/67	1122	1180	35	13	3	37
1967/68	1315	1214	55	25	4	45
1968/69	1507	1289	104	75	7	72
1969/70	1700	1502	176	140	10	80
1970/71	1938	1663	220	180	11	82
1971/72	2300	2111	280	235	12	84
1972/73	1315	1039	295	270	22	92
1973/74	2339	2112	348	300	15	86
1974/75	2500	1872	608	560	24	92
1975/76	2863	2442	313	250	11	80
1976/77	2675	1982	787	730	29	93
1977/78	1677	1297	397	365	24	92
1978/79	2791	2155	614	560	22	91
1979/80	2863	2111	652	590	23	90
1980/81	3200	2142	1108	1045	35	94
1981/82[c]	4350	3257	1135	1100	26	97
1982/83[c]	3300	2150	1100	1065	33	97

Source: Data supplied by Ministry of Agriculture and Cooperatives and Department of Customs.

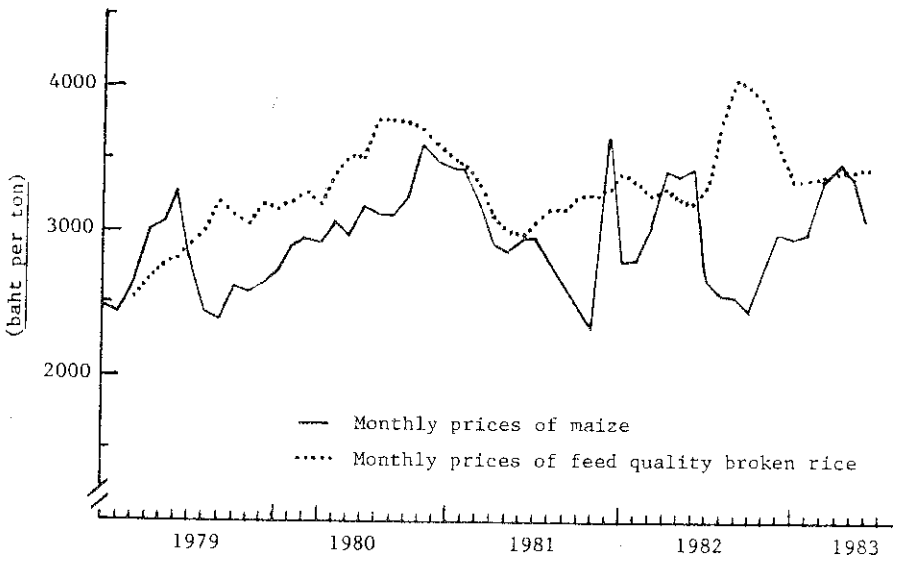
a. All data are for July-June cropyears.
b. Does not include beginning or ending stocks; therefore, exports and domestic consumption do not add up to production.
c. USDA, FAS/Bangkok estimates.

Figure 2.3: THAILAND: PRODUCTION AND UTILIZATION OF MAIZE, 1960/61-1982/83



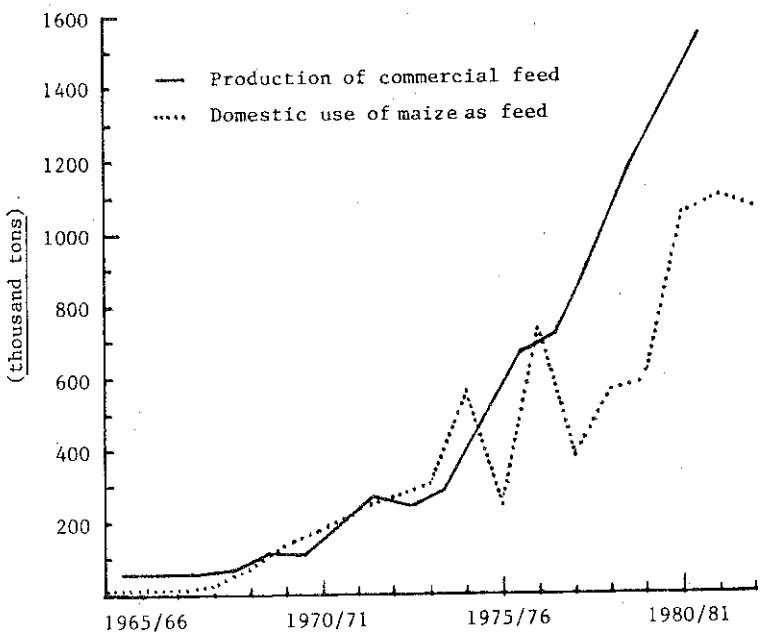
Source: Table 2.3.

Figure 2.4: THAILAND: PRICES OF BROKEN RICE AND MAIZE, 1979-1983



Source: Data supplied by Star Feedmill, Bangkok.

Figure 2.5: THAILAND: COMMERCIAL FEED PRODUCTION AND DOMESTIC USE OF MAIZE, 1964/65-1982/83



Source: Data supplied by Department of Business Economics. Table 2.3.

Increased fertilizer application could have a major impact on yields. Largely because government measures to protect local fertilizer manufacturers have raised prices and inhibited distribution, fertilizer consumption in Thailand is one of the lowest in Asia in terms of average consumption per land unit; very little of this is used on maize (79). In Table 2.4, fertilizer consumption in Thailand is compared with that in other Southeast Asian countries; it is half that in the Philippines and less than one-sixth that in Malaysia. The crop/fertilizer price ratios and value/cost ratios for paddy given in Table 2.4 indicate that, due to high fertilizer prices, fertilizer application is less profitable in Thailand than in the other countries.

Use of improved seeds is another area which shows promise. With 1.8 million hectares planted to maize, and 20 kilograms of seed needed per hectare (35, p. 12), a potential 36,000 tons of seed could be used each year. Government production of maize seed is only 800 to 1000 tons per year, and the distribution system is not very efficient. Feed companies, however, with a vested interest in ensuring sufficient maize supply, have begun to fill this gap in seed production. Private seed production was about 6000 tons in 1983, and the annual rate of growth between 1980 and 1983 ranged from 25 percent to 50 percent (11).

Despite the lack of new land to exploit, maize production has tremendous potential for expansion in the long run. Large increases may not occur in the short run, however, because of unfavorable price relationships which discourage the use of improved inputs.

Cassava

The story of cassava production in Thailand is another tale of astonishing growth, and one which has made Thai farmers famous for their responsiveness to external demand conditions. Commercial production began in the southeast in the 1930s and expanded after the war; this production was geared toward the export of cassava flour and starch to the U.S. and Japan for industrial use.

In 1956, the by-products of this starch processing (cassava meal and waste) were introduced to the European commercial feed industry. This market proved such a lucrative one that roots were later processed directly into chips and then pellets for feed use. As one can see from Figure 2.6, Thai cassava exports (which account for virtually all of production) have risen sharply, particularly in the last decade, and this growth has been entirely due to the European feed demand for cassava products, as flour production has remained constant.[8]

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[8] Boonjit (6 and 7) gives a more complete history of the development of the Thai cassava industry.

TABLE 2.4

FERTILIZER CONSUMPTION AND CROP/FERTILIZER PRICE RATIOS FOR SOUTHEAST ASIAN COUNTRIES, CA. 1975-1980

	Thailand	Philippines	Malaysia	Indonesia
1980 Fertilizer consumption[a] (100 grams N, P_2O_5 and K_2O per hectare arable land and permanent crops)	162	337	1051	630
Crop/fertilizer price ratio[b] For paddy, 1976.	0.59	0.76	1.15	0.96
Average value/cost ratio[c] For paddy, 1973/74-1976/77.	2.16	3.67	2.00	4.90

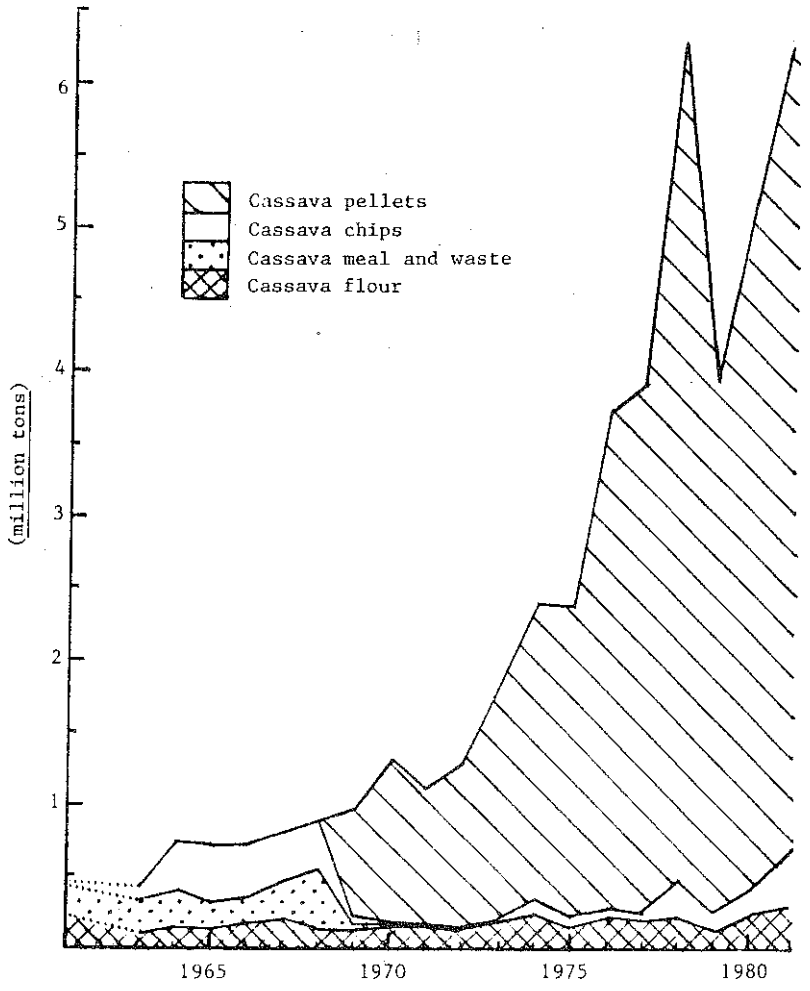
SOURCES:

a. FAO, Fertilizer Yearbook, 1981.

b. APO, Fertilizer Distribution in Selected Asian Countries (Tokyo, 1979), p. 195.

c. Ibid., p. 220. Averages of various country studies (using different fertilizer doses and different crop varieties).

Figure 2.6: THAILAND: EXPORTS OF CASSAVA PRODUCTS, 1961-1981



Note: Data are missing for 1962.
Pellets are included with meal/waste prior to 1969.

Source: Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.

This growing European demand set the stage for a tremendous expansion of Thai cassava production in the 1970s. As was the case for maize, this expansion was driven by an increase in production area rather than in yield. The area planted to cassava multiplied from an average of 0.04 million hectares in 1956-1958 to a 1.1 million hectare average in 1979-1981, an annual growth rate of 14 percent for these years. The growth compared to that of maize is shown in Figure 2.7. As dramatic as the expansion in maize production has been, the percentage increase in cassava production has been even greater. Yields, however, have decreased from a 1960-62 average of 17.1 tons per hectare to an average 13.8 tons per hectare in 1979-81. These low yields[9] reflect both the low use of improved inputs and the tendency to bring marginal land under cultivation.

Cassava, which is easily propagated, inexpensive to produce and a low-risk crop because of the flexibility of harvest time, has become since 1970 an important crop to the economy of the impoverished Northeast. This area has poor soils, unpredictable rainfall, and multiple socio-economic problems: it has the lowest average farm income in the country (12,000 baht per farm versus a national average of 20,000 baht per farm) and must cope with tensions along the Lao and Cambodian borders. Cassava production now accounts for 30 percent of the average agricultural income in this region (compared to eight percent in the Central region, and less in the North and South). Sixty percent of the land now planted to cassava lies in the Northeast; the Southeast, which twenty years ago provided the bulk of cassava production, now accounts for only 30 percent of the cassava-growing land. (See Map 2.2.)

Cassava as feed

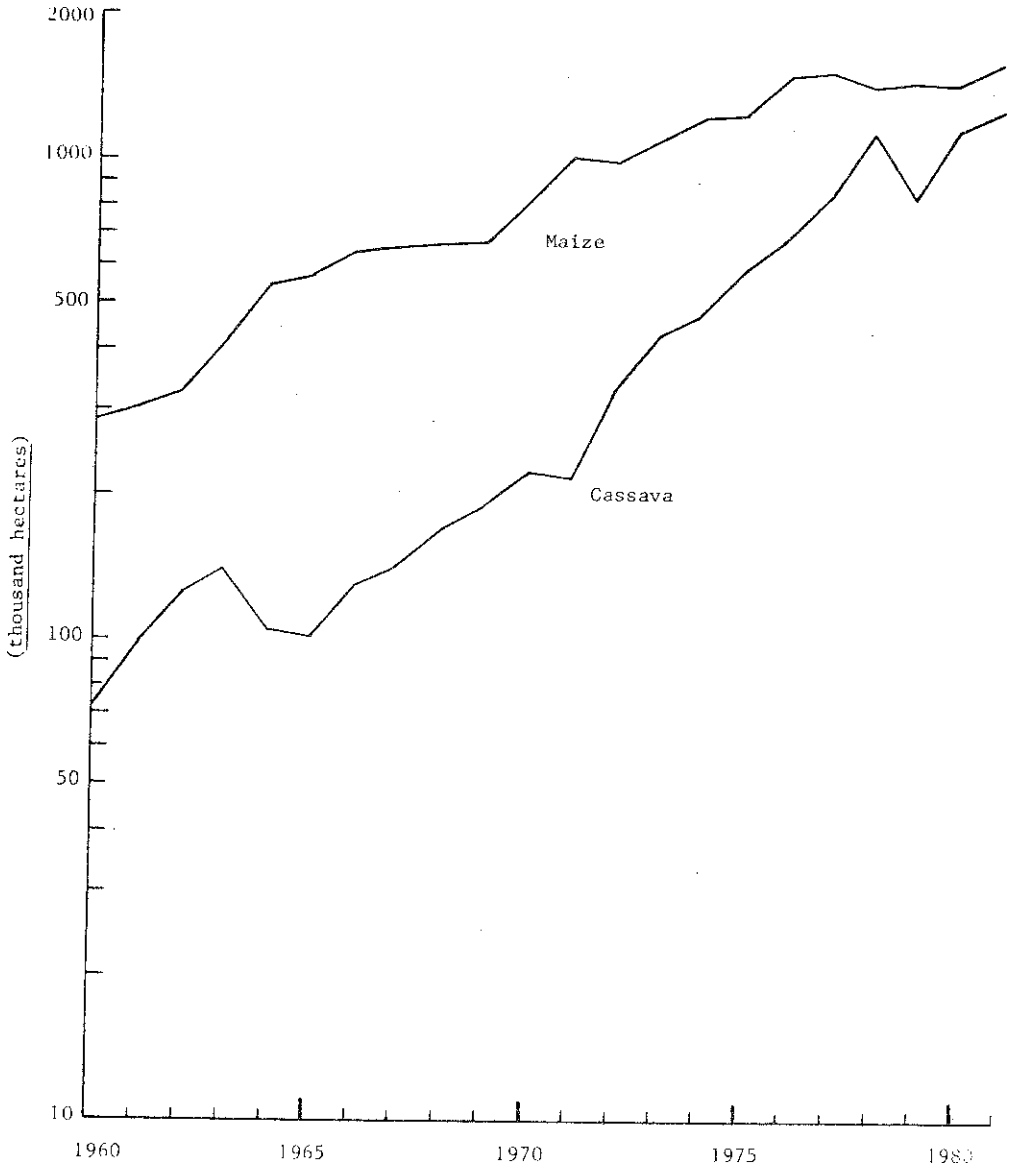
With 20-25 percent of its fresh weight composed of starch, cassava is an easily digested source of energy and can substitute for the traditional feedgrains. The nutrient value of cassava when used in pig feed is compared below with that of commonly used grains (40, p. 4):

	Protein	Digestible Energy
	(%)	(kcal/kg)
Cassava	2.84	4,000
Barley	13.03	3,467
Maize, dent yellow	9.89	3,961
Wheat, soft red winter	11.86	4,254
Soybean meal, expeller	47.33	3,870

[9] At the Centro Internacional de Agricultura Tropical (CIAT), yields in excess of 50 tons per hectare have been achieved.

Figure 2.7: THAILAND: MAIZE AND CASSAVA, AREA PLANTED, 1960-1981

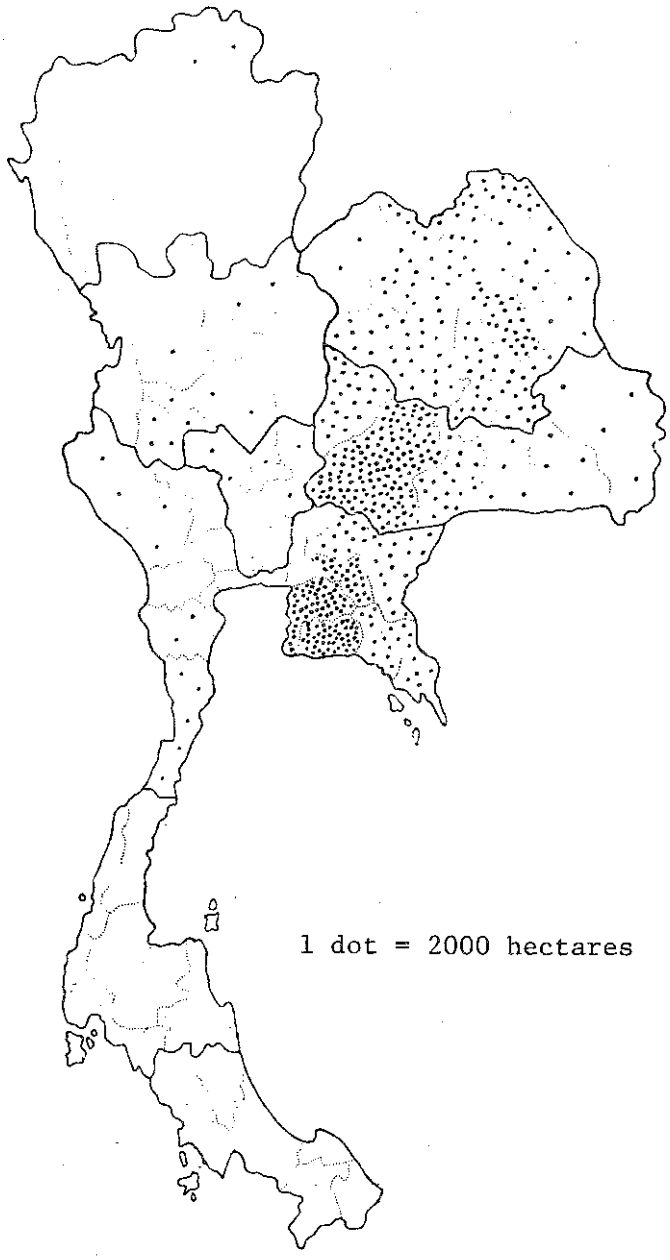
(logarithmic scale)



Note: Prior to 1977, cassava data are for cropyears.

Sources: Thailand, MOAC, Agricultural Statistics of Thailand various issues (cassava).
Maize data supplied by UNICOOP JAPAN.

Map 2.2: THAILAND: GEOGRAPHICAL DISTRIBUTION OF CASSAVA PRODUCTION, AVERAGE 1979-1981



Source: Thailand, MOAC, Agricultural Statistics of Thailand, Crop Year 1981/82, p. 32.

Cassava is low in protein (less than three percent, about one-fifth that of other feedgrains). For this reason it must be supplemented with a high protein feed such as oilseed meal. The ability of cassava to compete with feedgrains therefore depends upon the price of cassava as well as upon the price of available protein feeds.

European export market

Cassava, which had been known as an animal feed before the war but had declined in use as feedgrains became cheaper (32), was given a competitive edge with the formation of the European Community's Common Agricultural Policy in 1968. Community grain prices are maintained at a level higher than those prevailing on the world market by imposing variable levies on imports. The maximum levy on cassava imports, however, is set at six percent ad valorem.[10] In addition, oilseed meals are imported duty free, which provides a cheap protein supplement to cassava.

Although calculation of least-cost feed rations is necessary to accurately assess the price competitiveness of different feeds, Thai cassava exporters have used as a gauge the rule that the total cost of four tons of cassava pellets plus 1.5 tons of soybeans cannot exceed the cost of four tons of maize[11] (6). In Figure 2.8, the price of a cassava/soybean meal mixture is shown as a percent of both maize and barley prices in the EEC. From mid-1974 to mid-1981 (excluding excluding cropyear 1977/78, for which price data were not available), the price of cassava/soybean meal averaged 88 percent of the price of imported maize and only 77 percent of the price of feed barley. Clearly, the advantageous tariff situation of both cassava and oilseeds made cassava very competitive in the European market.

Thailand's rapid response to the fortuitous European feed market situation resulted in EEC imports of Thai cassava products soaring from less than 1 million tons in 1968 to more than 6 million tons a mere ten years later (see Figure 2.6); in fact, a third of this increase occurred in one year, from 1977 to 1978, at which time cassava accounted for 6.3 percent of all raw material use in European commercially-mixed feeds (40, p. 10). This led to a great deal of concern on the part of European feedgrain producers and to EEC pressure on Thailand to restrict her exports. An agreement was signed

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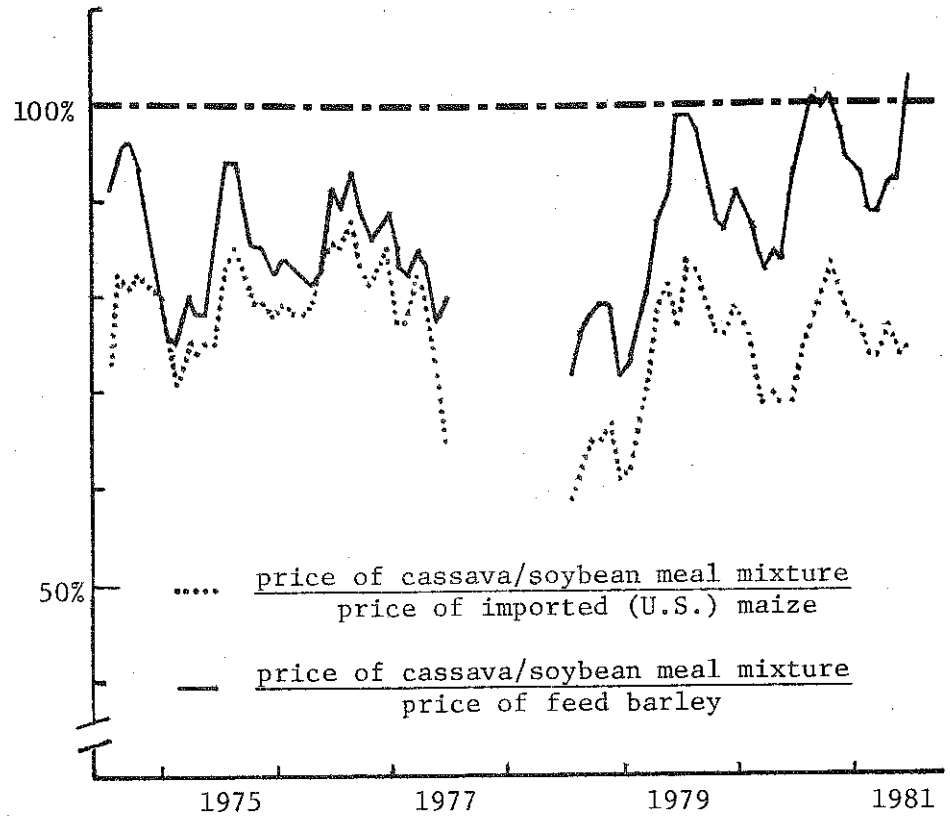
10 For a more detailed description of the duties imposed on cassava products, see Nelson (40).

11 This translates into a mixture that is about 20 percent soybean oil meal. Sarote and Jowaman (cited in 49, p. 254) use a lower protein figure of 15 percent soybean meal/85 percent dried cassava root as a rough maize equivalent. Using these numbers would make a cassava/soybean meal mixture even more competitive than indicated in Figure 2.8.

Figure 2.8: EEC: PRICE OF CASSAVA/SOYBEAN MIXTURE AS PERCENT OF MAIZE AND BARLEY PRICES, 1974-1981



Note: Barley prices are wholesale prices in Hannover, West Germany. Other prices are wholesale prices in Hamburg, West Germany. Prices for 1977/78 are not available.

Source: Zentrale Markt- und Preisberichtstelle fuer Erzeugnisse, ZMP Bilanz: Getreide-Futtermittel 1976/77 and 1980/81 (Bonn).

in 1982, in which Thai exports to the EEC would decrease to 4.5 million tons by 1985.

Potential for domestic use

This newly restricted access to the European market poses substantial problems for Thailand. Cassava products are now the most valuable agricultural export after rice (in 1978, in fact, the value of cassava exports exceeded that of rice exports), and more that 90 percent of these exports go to the EEC. Especially because of the particular dependence of the Northeast upon this crop, much attention has been focused upon developing alternative markets for cassava. One often-cited alternative is the possibility of using cassava products domestically as livestock feed.[12]

The economic viability of using cassava for feed within Thailand, however, is dubious. Researchers at Khon Kaen University, who have been investigating cassava's value as feed since 1975, concluded that total substitution of cassava for cereals is possible, as long as the cassava diets are carefully formulated to include adequate protein and fat.

This substitution, however, is economical only when the cassava price is 50 percent or less of the price of cereals, assuming that prices of protein and fat remain constant (58, pp. 5, 7). Figure 2.9 plots the price of cassava in Thailand as a percent of the price of maize; it is readily apparent that cassava prices have very seldom been low enough compared with feedgrains to make their use within Thailand economical.

Domestic use of cassava is made still less attractive by the fact that prices of protein feeds (which are needed to supplement cassava's low protein content) have risen in recent years, much more than grain prices. From 1975/76 to 1981/82, the price of maize increased 23 percent and the price of broken rice rose 41 percent. During the same period, soybean meal and fishmeal prices rose 73 percent and 81 percent, respectively.[13] (See Figures 2.4 and 2.10.) In addition, taxes on soybean meal imports, which now provide the bulk of soybean meal consumption (see the following section), have increased in the last six years. Taxes on soybean meal imports (including the business

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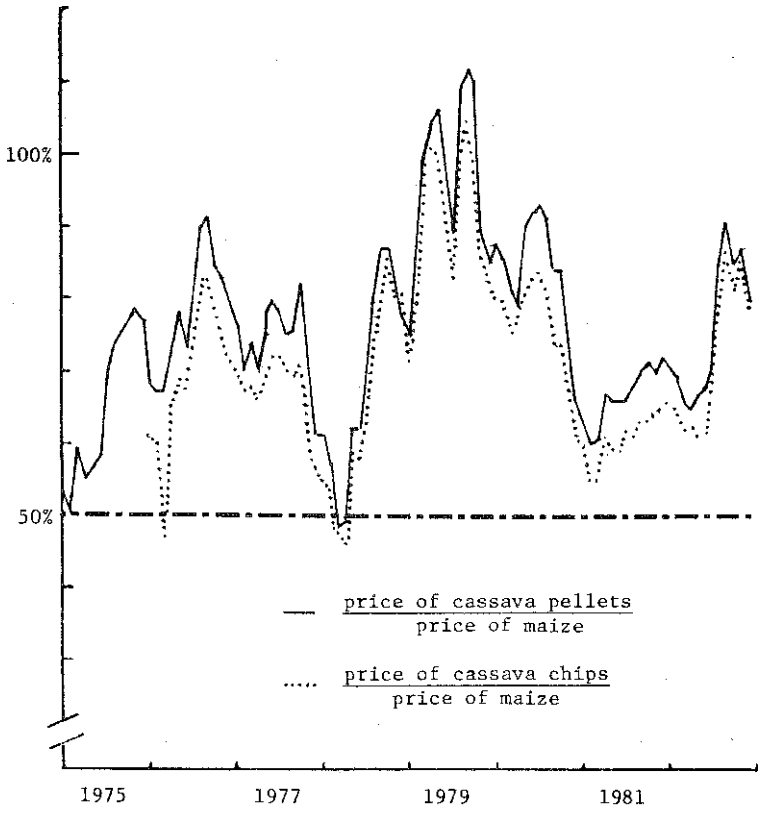
[12] A 1981 report, for example, estimated that 1.5 million tons of excess cassava could replace 60 percent of the rations for swine to raise 17.4 million hogs, which would mean a threefold increase in hog production (80, p. 63).

[13] However, soybean meal prices vary greatly from year to year and this upward price trend may not continue. In 1984, for example, U.S. soybean meal prices dropped to 1977/78 levels.

Figure 2.9: THAILAND: CASSAVA PRICE AS PERCENT OF MAIZE PRICE, 1975-1982



Source: Cassava prices supplied by Thai Tapioca Trade Association.
Maize prices supplied by Department of Commercial Relations.

tax) rose from five to six percent in the late 1970s to 8.5 percent in 1983 (16).

Protein Feeds

In contrast to the surplus supply situation for energy feeds in Thailand, in which production has multiplied to meet rapidly rising demand for both export and domestic use, production of supplemental protein feeds has grown less dramatically, and imports have risen. The primary ingredients used as protein additives are fishmeal and soybean meal; other oilseed meals are also used (e.g., peanut, coconut, or sesame oil meals), but they are not as significant and data on them are scarce.

Fishmeal

Fishmeal is processed from trash fish,[14] too small to be sold for human consumption, and is an excellent source of protein (protein content is usually around 60 percent), calcium and phosphorus. As a readily available by-product of Thailand's large fishing industry, fishmeal was traditionally the major source of protein for animal feed. In fact, the excess supply of fishmeal in the 1960s, caused by overfishing, played a major role in stimulating growth in the infant feed industry, which at that time was primarily involved in the manufacture of protein feed concentrates for swine (80).

In recent years, however, the availability of trash fish has declined due to this earlier overfishing and to the imposition by neighboring countries of 200 mile territorial limits. The price of fishmeal has therefore risen relative to the price of soybean meal. This can be seen in Figure 2.10. Fishmeal prices also exhibit a great deal of variability. For these reasons, the increment in fishmeal production has been exported rather than used domestically. Figure 2.11 demonstrates that, although fishmeal production has tripled since 1970, domestic consumption has not increased much; the percentage of production used domestically has been halved in this time, from almost 80 percent in 1970 to less than 40 percent in 1982.[15]

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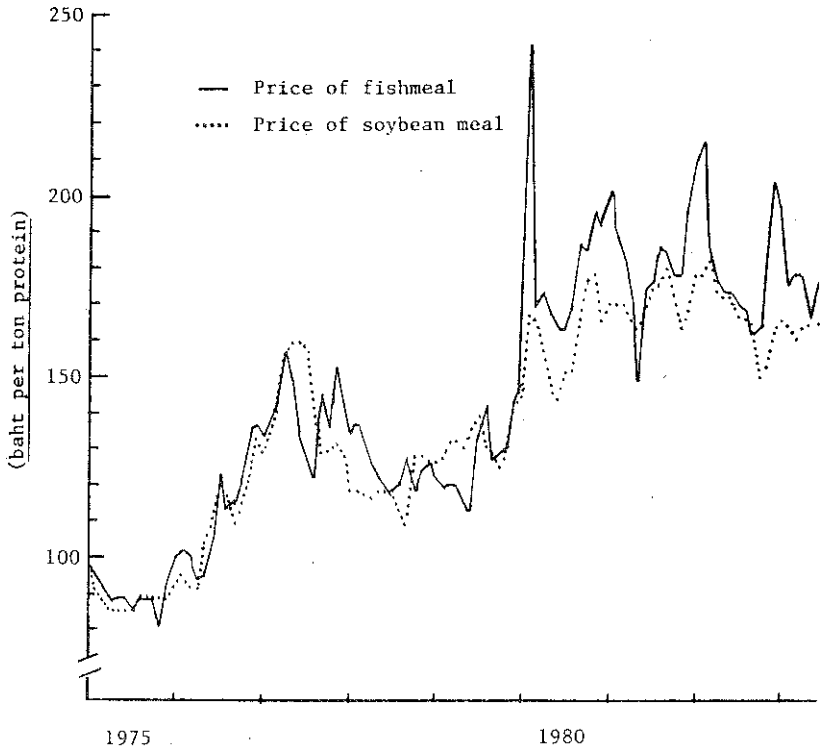
[14] About five kilograms of fish are needed to process one kilogram of fishmeal (75, p. 17).

[15] Imports of fishmeal are negligible. Production and trade statistics for fishmeal can be found in Appendix Table 2.

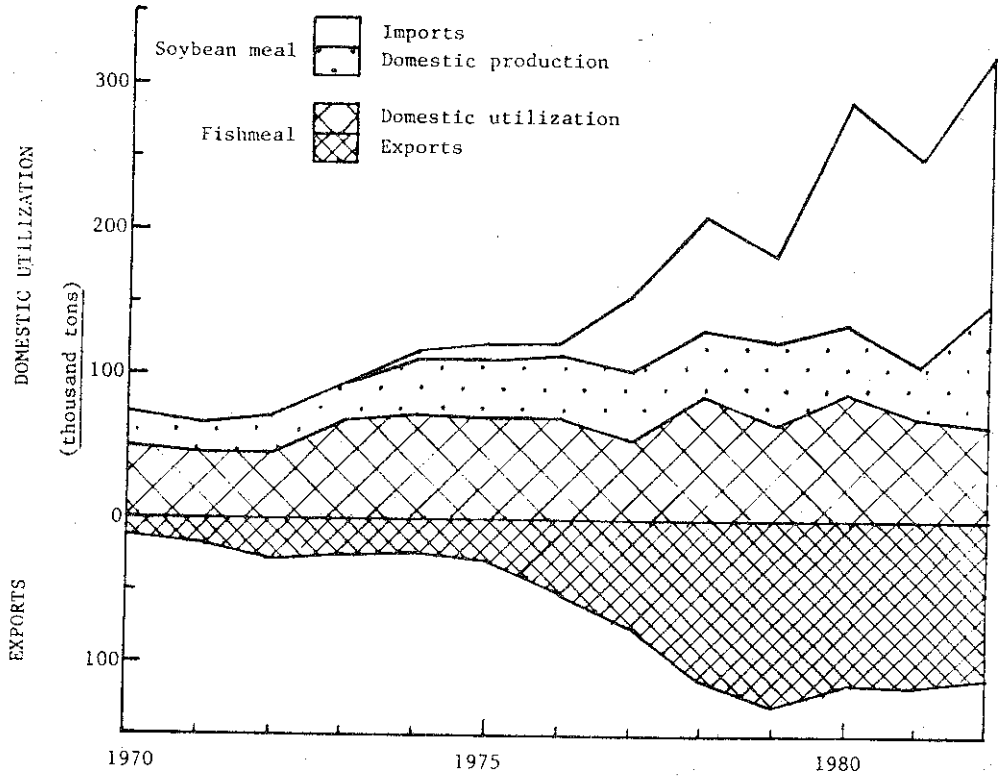
Figure 2.10: THAILAND: PRICES OF PROTEIN FEEDS, 1975-1983



Note: Prices are given in terms of baht per ton of protein. The price series for fishmeal was known to be for 60 percent protein, but the protein content of soybean meal was not known. Soybean meal in Thailand is generally of poor quality and was therefore assumed to be only 45 percent protein. If the meal actually contained more protein, the adjusted meal prices would be even lower relative to fishmeal prices. (For each additional one percent of protein, the price per unit protein is about two percent lower.)

Source: Data supplied by Star Feedmill, Bangkok.

Figure 2.11: THAILAND: PRODUCTION AND UTILIZATION OF PROTEIN FEEDS, 1970-1982



Sources: Data supplied by MOAC, Department of Fisheries and Department of Commercial Economics.
Department of Customs, Foreign Trade Statistics of Thailand, various issues.

Soybean meal

Soybean meal, or soybean cake, is the residue left after extracting oil from soybeans[16] and generally contains 44-49 percent protein. Because of its by-product nature, and because the Thai vegetable oil industry uses a wide variety of oilseeds, there are very few data specifically on soybean meal production. Apparently, however, about 45-67 percent of the soybean crop each year is used for oil extraction (63, p. 108; 49, p. 247; 71, p. 15).

Soybean meal consumption in Thailand, partitioned into imports and domestic production (exports are negligible), is also shown in Figure 2.11. One can see that, although soybean meal production more than doubled from 1970 to 1981, this production has not been enough to meet demand, and imports have had to increase substantially. In contrast to domestic consumption of fishmeal, which has remained about 50-85,000 tons annually, total consumption of soybean meal has grown almost tenfold to a current usage of about 200-250,000 tons per year. Imports now account for 80 percent of this quantity.

The prospects for increasing domestic production of soybean meal will depend upon the demand for and production of vegetable oil, as well as the demand for and supply of soybeans as a raw material. The production of vegetable oils has not risen sufficiently to meet the increased demand of recent years, and imports have become more important. From 1979 to 1982, imports of edible oils averaged about 33 percent of total supply (79, p. 21). This inadequate level of production is due primarily to insufficient supply of raw materials and to inefficient production.

Soybeans are a preferred material for oil extraction because the meal is more valuable than other oilseed meals. Soybean production more than doubled from 1970 to 1981, but soybeans are mainly a temperate crop and production in Thailand is characterized by low yields and high costs (49). Production incentives are thus not high. Oilseed prices are determined by the world market and when prices are high, farmers sell their crop into the export market, leading to domestic shortages.

Domestic soybean meal does not compete well with imported meals. The quality is poor, due to the low protein content of Thai soybeans (49; 70). In addition, the vegetable oil industry is characterized by a large number of small factories using old techniques; these inefficient extraction practices result in a residue which has a higher percentage of oil than is desirable for animal feed (4). The price of domestic meal, however, is higher than that of imported meals: from 1975 to 1982, the CIF value of imported soybean meal averaged 5.4 baht per kilogram (74), whereas domestic meal prices averaged 6.1 baht per kilogram (64).

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[16] One hundred kilograms of soybeans generally yield about twenty kilograms of oil and eighty kilograms of meal (73).

Thus, from Figure 2.11, two recent shifts in the supply situation of protein feeds are clear. First, although fishmeal was the most important source of protein through 1976, this is no longer true. Consumption of soybean meal is now two to three times that of fishmeal. Second, because of this increased preference for soybean meal and the inadequacy of domestic supply, there has been a shift from net exports of these protein feeds to net imports.

Aggregate Feed Supply

The aggregate supply of the primary feeds used in Thailand, i.e., rice products and maize, is shown in Table 2.6; these numbers are, of course, dependent upon the assumptions made in the previous sections. Charoen Pokphand, the largest feed manufacturer, estimated feed ingredient use in calendar year 1976 (52):

Rice by-products	2,170,000 mt
Corn	600,000
TOTAL	2,770,000 mt

These estimates are somewhat lower than those in Table 2.6, but are at least in the same range and thus add a measure of confidence to the foregoing discussion of supply.

Rice products are still the most important feed ingredient, but their proportion of total feed supply decreased from more than 90 percent in the early 1970s to 75 percent in 1982. Total domestic feed supply of rice products and maize increased by about 65 percent from 1970 to 1982.

TABLE 2.6

THAILAND: AGGREGATE SUPPLY OF MAJOR FEED INGREDIENTS, 1970/71-1982/83

Cropyear	Rice Products[a]				Maize[b]	Total Supply of Feed Ingredients	As % of Total Feed	
	Broken Rice	Fine Bran	Coarse Bran	Total			Rice	Maize
	(1000 tons)							
1970/71	1167	923	434	2524	180	2704	93	7
1971/72	1182	935	440	2556	235	2791	92	8
1972/73	1068	912	397	2377	270	2647	90	10
1973/74	1281	1013	477	2771	300	3071	90	10
1974/75	1151	910	428	2490	560	3050	82	18
1975/76	1316	1040	490	2846	250	3096	92	8
1976/77	1296	1025	482	2803	730	3533	79	21
1977/78	1197	947	445	2589	365	2954	88	12
1978/79	1502	1188	559	3249	560	3809	85	15
1979/80	1355	1072	504	2931	590	3521	83	17
1980/81	1529	1209	569	3306	1045	4351	76	24
1981/82[c]	1613	1275	600	3488	1100	4588	76	24
1982/83[c]	1484	1173	552	3209	1065	4274	75	25

SOURCES:
a. From Table 2.2.
b. From Table 2.3.
c. Based on USDA, FAS/Bangkok estimates.

Chapter III

THE LIVESTOCK SECTOR

Many species of livestock are kept in Thailand. However, the only animals of consequence in terms of feed consumption are swine and poultry, both of which have come under increasingly commercial production.[1] Most rice farmers own cattle or water buffalo, but the bulk of their feed is obtained from grazing. Other animals include elephants, horses, and mules, but their populations are small and are decreasing. (See Appendix Table 4.)

Swine

Swine are the most significant consumers of feed ingredients. The bulk of the rations is provided by rice bran and broken rice, supplemented by farm wastes. Most hogs are crossbreeds between native pigs and European or American breeding stock, and are produced under backyard conditions. Small-scale rice farmers will commonly maintain several pigs as a sideline for about ten months until they reach a market weight of 120-130 kilograms.[2]

Hog production

The major pig raising areas are the provinces around Bangkok. This is for reasons of both demand and supply. Bangkok is the largest single market for pork because of its size (roughly ten percent of the total population of Thailand) and high per capita income. Because the Central Plain is the major rice producing area, feed is readily available; this region accounts for 36-40 percent of total hog production (43, p. 442).

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[1] There is a lamentable lack of research done on feed and livestock production in Thailand. Much of the information about both swine and chicken production presented in this chapter is drawn from studies done in the past five years by Nipon Poapongsakorn of Thammasat University.

[2] According to Nipon (43), village pigs are usually raised to a heavier weight than those in commercial operations because transport and slaughter costs are charged on a per-pig basis.

In the last fifteen years, commercial hog operations have expanded. Holdings on such operations are larger (up to fifty pigs[3]), and management practices are more sophisticated. Rations include commercially-mixed feed (generally concentrate feed and premixes[4]). Hogs achieve a market weight of about 100 kilograms in five or six months. Commercial operations comprise only three percent of all hog producers (1; 43, p. 444), but they account for a significant proportion of production. A 1982 study estimated that the proportion of commercially raised hogs was 11.6 percent of total swine production in 1974 and increased to 13.7 percent in 1978 (61, p. 2). This corresponds to feed company estimates in 1983 of 10-15 percent penetration[5] (8; 12). However, unless government policies (to be discussed in the following section) change, much further expansion in commercial hog production is unlikely.

Government regulation in the swine industry

A major constraint to the development of the swine industry is the Animal Slaughtering and Meat Sale Control Act of 1959, which is enforced by the Ministry of Interior. Under this law,

1. Only local authorities and municipalities are permitted to establish slaughterhouses. Private slaughterhouses are allowed only with special permission and with the property rights transferred to the local government.
2. All pigs slaughtered must be inspected and granted a slaughter permit.
3. Shipment of carcasses outside the legal market area of each slaughterhouse is prohibited. The purposes of this law are to provide income for local government, to control illegal slaughter, and to ensure hygienic slaughtering practices.

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[3] The 1978 Agricultural Census reported that only 0.5 percent of all swine were raised in holdings exceeding fifty hogs (43, p. 443).

[4] Thai feed companies group commercial feed into two basic categories: complete feeds and concentrate feeds. Complete rations are feed mixtures which include all the required nutrients, except water, for a given class of livestock. Concentrates are feeds low in crude fiber and high in total digestible nutrients (especially protein), with which farmers supplement energy feeds (e.g., grains). These terms are used in this thesis. Other sources refer to these two categories as energy concentrates and protein concentrates. Premixes are mixtures of the micronutrients needed in any feed ration; these are imported into Thailand.

[5] Penetration refers to the degree to which the demand for feed is met by commercially-mixed feeds, which is an indication of commercial livestock production.

In practice, however, the effects of this law have been counter-productive.

First, standards are very low and hygiene is poor. Slaughterhouse operators have little incentive for maintenance since they do not own the property rights; nor are improvement or investment in slaughterhouses required. A 1976 survey of twelve northeast provinces found no slaughterhouses equipped with slaughtering machines or refrigeration facilities (43).

Second, the charges and taxes levied on slaughtered pigs are high, which encourages corruption and a great deal of unreported slaughter.[6] Various studies estimate that illegal slaughter accounts for 50-66 percent of total slaughter (43, p. 463; 80, p. 4).

Third, pigmeat inspection is under the control of the Ministry of Interior rather than the Department of Livestock Development (DLD, a division of the Ministry of Agriculture and Cooperatives, MOAC), as is the case for chicken processing. Inspectors are often not qualified and corruption is widespread.

Fourth, the law prohibits shipping pig carcasses across the boundaries of trading areas, and there is usually only one slaughterhouse in each trading area. This creates a local monopsony in the carcass wholesaling trade and means that hogs are often hauled long distances to market (sometimes more than ten hours). Because there is no premium for careful handling, pigs often arrive at the slaughterhouse in poor condition.[7]

Estimation of swine production

Estimates of the current swine population in Thailand range from 4 million to 8 million. Table 3.1 exhibits some of these various opinions over time. The official government figures are the lowest and indicate a stagnant production trend in the fifteen years from 1967 to 1981. The figures in Column A are based upon an annual survey taken on April 1 each year, but it is unclear whether these numbers include both small-farm and commercial production. Column B gives government estimates for annual hog consumption. These are supposedly derived from per capita consumption, but this seems suspicious, for

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[6] Nipon reports, for example, that the modern slaughtering facilities at the Bangkok municipal abattoir have not been used for years because the machine would automatically record the number of hogs slaughtered (43).

[7] Nipon (43) goes into much more detail regarding the deleterious effects of government regulations for swine. These conditions are also described in Vallentine et al. (80), and were recounted as well in interviews at the DLD.

there is no evidence of any time-series consumption surveys. Furthermore, per capita pork consumption figures, re-calculated from these numbers, are lower than other estimates. (Figure 3.1 presents a comparison of various consumption estimates; these will be discussed more fully later.)

Because of the relatively short life cycle of hogs (less than one year), the number of slaughtered animals might be considered a better estimator of yearly production and consumption[8] (and hence feed use) than annual survey data. As explained in the previous section, however, reliable slaughter data are unobtainable because more than half of the slaughter is unreported. The official slaughter figures are given in Column C; they vary from 33 percent of the offical swine population estimate in 1973 to 108 percent in 1979.

Alternative slaughter and production estimates, given in the next three columns of Table 3.1, present a much different picture of hog production than is evinced by official population data. They suggest a distinct upward trend. Estimates by the National Economic and Social Development Board (NESDB) in the mid-seventies, adjusted for illegal slaughter, are displayed in Column D. The NESDB assumed a constant 51 percent of total slaughter to be unregistered. The figures from Thammasat University for 1973-75, given in Column E, yield estimates of unreported slaughter of 66 percent, 64 percent, and 62 percent, respectively, for the three years. Estimates by the Bangkok Bank of swine production in the mid-seventies (Column F) are much higher than either of the adjusted slaughter estimates. These figures are probably too high, for three different feed company officials in 1983 independently judged swine production to be 6-7 million hogs (8; 12).

In Column G is presented a consistent series of slaughter estimates, derived by assuming a conservative 50 percent unreported slaughter. These estimates indicate that swine production, contrary to being stagnant, in fact doubled from 1967 to 1981. This, of course, assumes that illegal slaughter has been a constant proportion of total slaughter, which is improbable. However, variation in the amount of unreported slaughter is likely to occur from year to year. There is no reason to suspect either a decreasing or increasing trend over time in the proportion of unreported slaughter, since the regulations leading to this situation have not changed in thirty years.

Two conclusions can be reasonably drawn from these estimates. First, because of the conservative assumption regarding illegal slaughter (50 percent), the numbers may well be on the low side. Second, production seems to have increased considerably during the

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[8] Although hogs are at times kept for two or more years, they are generally slaughtered before one year. Therefore, with such grossly aggregated data, we can assume hog production and pork consumption to be equal.

TABLE 3.1

THAILAND: ESTIMATES OF SWINE PRODUCTION, 1967-1981

(1000 head)

Year	MOAC Statistics			Other Estimates			Author's Estimates
	Population	Hogs Consumed	Reported Slaughter	Slaughter		Population	
				NESDB	Thammasat		
	A	B	C	D	E	F	G
1967	4,222		1,714	3,497			3,429
1968	4,503		1,712	3,492			3,424
1969	4,807		1,449	2,957			2,899
1970	5,132		1,607	3,279			3,215
1971	3,884		1,674	3,415			3,348
1972	3,982	2,743	1,668	3,402			3,335
1973	4,510	2,805	1,502		4,445		3,004
1974	3,846	2,906	1,628		4,555	6,652	3,256
1975	3,548	3,010	1,933		5,089	7,098	3,866
1976	3,404	3,236	2,600			7,573	5,201
1977	3,275	3,329	2,710			8,081	5,420
1978	5,324	3,483	3,357			8,622	6,713
1979	3,396	3,519	3,672				7,343
1980	3,021	3,562	3,295				6,589
1981	3,616	3,737	3,224				6,448

SOURCES:

A. Thailand, MOAC, Agricultural Statistics of Thailand Crop Year 1981/82, p. 84 (based on annual survey data.)
B. Thailand, MOAC, Department of Agricultural Economics, "Demand and Production of Agricultural Products" (Bangkok, 1982).
C. Thailand, MOAC, Agricultural Statistics of Thailand Crop Year 1981/82, p. 93.
D. Thailand, NESDB, cited in A.J. De Boer, Livestock and Poultry Production in Selected Asian Countries (Tokyo, 1975), p. 90.
E. Thammasat University, 1980, cited in Vallentine et al., "Interim Findings: Provisional Draft BOI Programme on the Livestock and Meat Products Sector" (draft, 1981).
F. Bangkok Bank, cited in Nipon Poapongsakorn, The Animal Feed Industry in Thailand (Bangkok, 1981).
G. Assumes 50% unreported slaughter.

1970s. Because the figures are derived from questionable statistics, one should not assume that a particular figure actually represents the slaughter for that year. (For example, the 35 percent jump in slaughter from 1975 to 1976 is improbable.) But the apparent increasing trend during these years (1967-1981) is supported both by other estimates and by the fact that feed supply of rice products and maize grew substantially during this period as well.

Consumption of pork

As a further check on the credibility of the hog slaughter estimates presented in the previous section, the figures can be converted to per capita consumption and compared with other consumption estimates. In order to do this, trade must first be accounted for.

Trade in live hogs and pork, shown in Table 3.2, consists primarily of exports. Imports of live pigs are negligible, and no pork meat is imported at all. Due to periodic outbreaks of diseases such as hog cholera and foot and mouth disease, live hog exports have been erratic and are not significant. Even in 1970, when a record 15,000 pigs were exported, these exports amounted to less than one percent of estimated production. Exports of pork meat, which mainly go to Hong Kong, have also been irregular and are constrained by the poor slaughterhouse conditions, as foreign countries are wary of accepting unhygienic meat. Net trade in both live hogs and pork is shown in the last column of Table 3.2. This trade was taken into account when converting estimated slaughter into consumption, but it affected annual per capita consumption figures very little (by a tenth of a kilogram at the most).

Annual pork consumption was calculated from the slaughter estimates given in Column G of Table 3.1, plus or minus net trade. Hogs were assumed to be 100 kilograms at slaughter[9] and to yield 55 kilograms of meat when dressed.[10] These calculations were then divided

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[9] Although Nipon (43, p. 445) found that village pigs, which are the majority of the swine population, are usually slaughtered at 120-130 kilograms, other sources give lower liveweight figures. Sarote estimates village pigs are slaughtered at 100-120 kilograms (56). Vallentine et al. (80, p. 6) give a 100 kilogram liveweight figure for 90 percent of Thai hogs, as do feed company employees (12). The lower figure of 100 kilograms liveweight was chosen to provide conservative consumption estimates.

[10] In American hogs, boneless meat is generally about 55 percent of the slaughter weight. This appears to be the case in Thailand as well. FAO (25) gives 50 percent as the dressed carcass weight, and Nipon (43, p. 445) estimates pork meat to be 55-60 percent of slaughter weight.

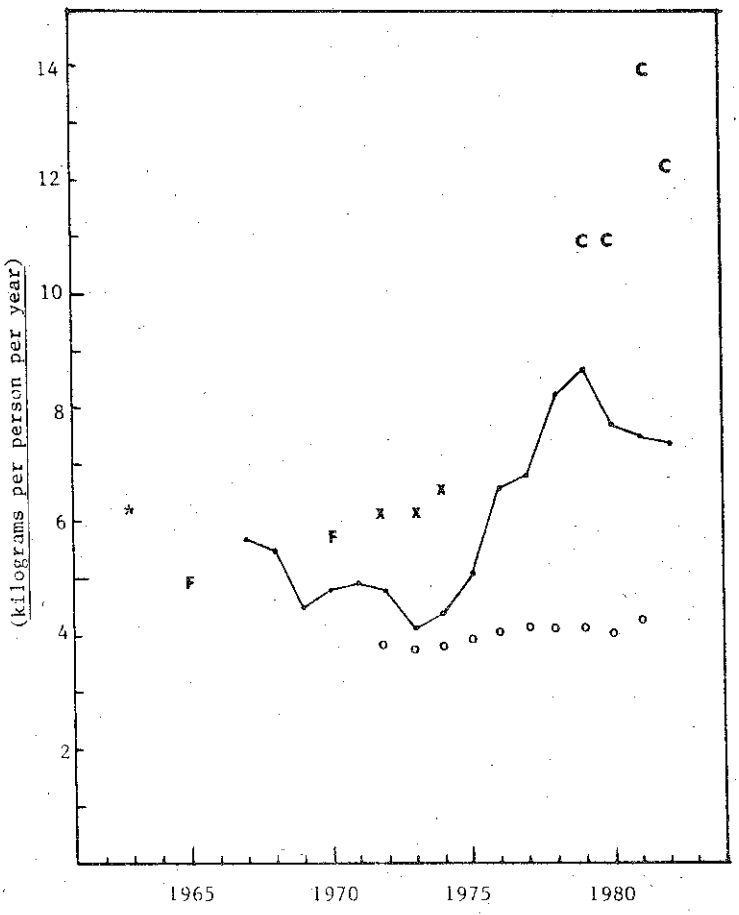
TABLE 3.2

THAILAND: TRADE IN LIVE SWINE AND PORK, 1967-1981

Year	Live Swine[a]		Pork Exports		Net Trade[c]
	Imports	Exports			
	——(head)——		(kilograms)[a]	(head)[b]	(head)
1967	9	9,733	3,696	67	- 9,791
1968	150	—	—	—	+ 150
1969	45	—	—	—	+ 45
1970	324	15,555	—	—	-15,231
1971	26	9,373	—	—	- 9,347
1972	401	1,229	—	—	- 828
1973	620	10,846	—	—	-10,226
1974	132	1,434	—	—	- 1,302
1975	10	141	81,687	1,485	- 1,616
1976	200	5,640	105,416	1,916	- 7,356
1977	1,103	639	15,786	287	+ 177
1978	783	3,114	1,288,005	23,416	-25,747
1979	199	6,300	537,376	9,769	-15,870
1980	621	172	38,098	693	- 244
1981	812	1,369	3,651	66	- 623

a. Source: Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.
b. Derived from kilograms exported, assuming 100 kilogram liveweight and 55% meat yield.
c. A negative sign indicates net exports.
A positive sign indicates net imports.

Figure 3.1: THAILAND: COMPARISON OF VARIOUS ESTIMATES OF PER CAPITA PORK CONSUMPTION, 1963-1982



— = Derived from Column G of Table 3.1 (assuming 50 percent unreported slaughter).
o = Derived from MOAC consumption estimates (Column B of Table 3.1).
* = Thai government Household Expenditure Survey (quoted in Asian Livestock, October 1976).
F = FAO estimates.
1965 and 1976 are 3-year averages from Food Balance Sheets.
1970 is from M.G. Fenn, Marketing Livestock and Meat, (Rome, 1977).
x = Derived from Thammasat University estimates (Column E of Table 3.1).
c = Feed company (C.P. estimates).

by the population in Thailand to derive the per capita consumption estimates displayed graphically in Figure 3.1. The points for each year are connected by a line to more easily differentiate them from other estimates; yearly increases and decreases may contain a large margin of error. Other consumption estimates provided for comparison are estimates from the MOAC (obtained by dividing Column B of Table 3.1 by population); a 1963 Thai government estimate from a Household Expenditure Survey; FAO estimates; estimates derived from Thammasat University slaughter figures (obtained using the same liveweight and dressing-out assumptions listed earlier); and feed company estimates (which are probably somewhat overstated).

Due to the absence of reliable consumption survey data, it is difficult to conclude much from these comparisons. It does seem apparent, however, that pork consumption is higher than the Ministry figures would indicate, and that there has been a sizeable increase.

These conclusions are given some support if one examines consumption figures from nearby Asian countries. Malaysia and Indonesia, of course, are predominantly Moslem cultures and consume very little pork. Per capita pork consumption estimates in the Philippines and in Taiwan, however, fall in the upper range of the estimates for Thailand. Estimates of per capita pork consumption in the Philippines in the early and mid-1970s range from 6.5 to 11.45 kilograms per year (22, p. 259; 38, p. 111). Similarly, two studies of Taiwan concur that annual pork consumption rose from 16 kilograms per person in 1964 to about 26 kilograms in 1980 (14, p. 157; 60, p. 46). Thus, the adjusted hog slaughter figures for Thailand which indicate current per capita pork consumption to be more than 7 kilograms do not seem unreasonable.

Future prospects

Future development of the swine industry depends upon prospects for growth in both demand and supply of pork meat. Pork is the preferred meat in Thailand and demand is strong, despite the fact that pork is considerably more expensive than beef, chicken, or fish.

Real prices of these animal products for 1967-1982 are shown in Figure 3.2; income is plotted on the right-hand axis of the same graph.[11] One can see that pork prices have been variable during this period, and that there has been a general upward trend. Beef prices, however, have increased more in relative terms. And real income has risen still more, making all meats relatively cheaper in the 1980s than they were in the 1960s.

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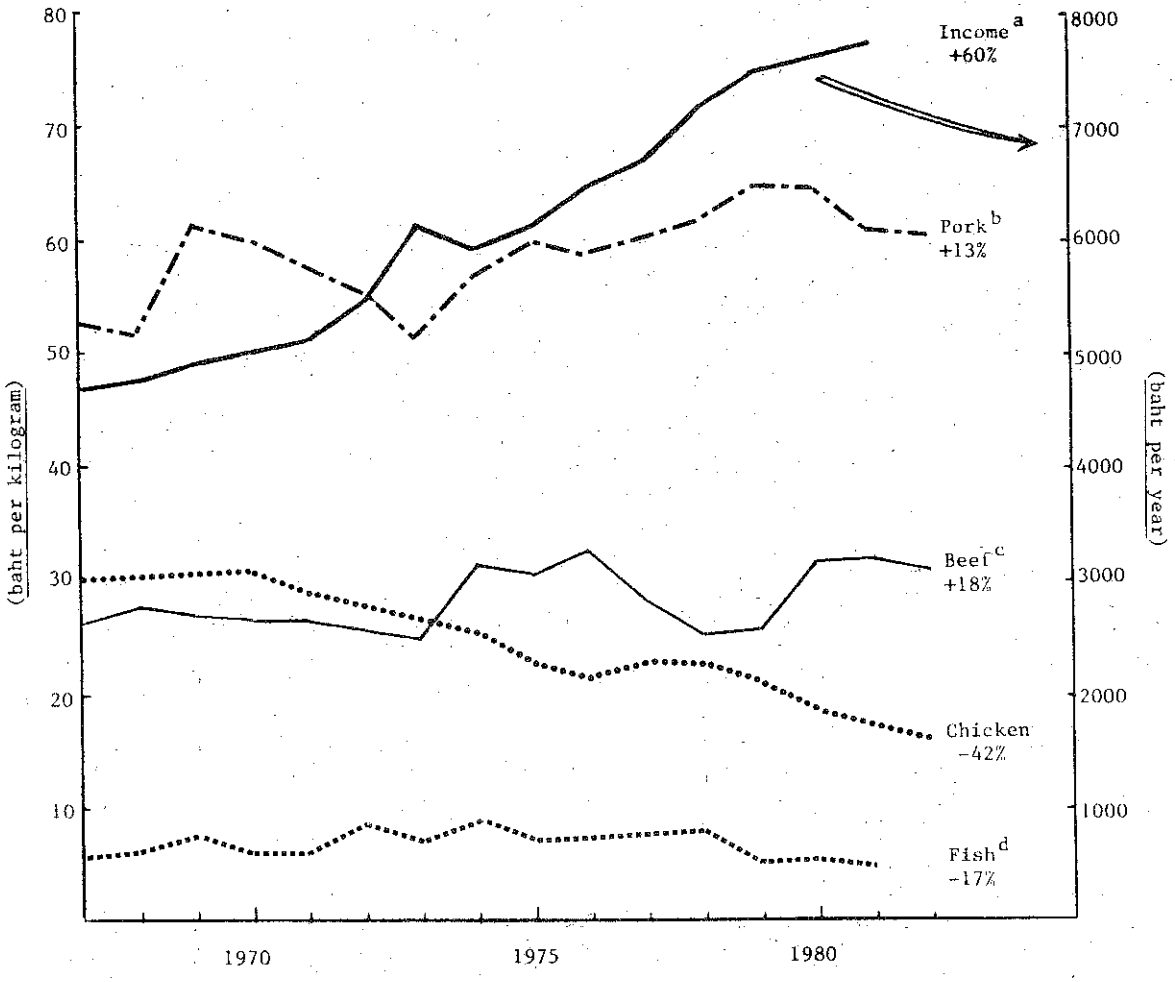
[11] The pork prices shown here are a little misleading, for this price series is for a slightly processed kind of meat. Prices of unprocessed pork meat would therefore be somewhat lower, although still higher than those of the other meats.

Figure 3.2: THAILAND: RETAIL PRICES OF MEAT AND FISH, DEFLATED BY CPI, 1967-1982



a. Per capita real income, measured on right axis.
b. Price of muu deeng, slightly processed pork.
c. Includes meat from cattle and water buffalo.
d. Average wholesale price of mackerel (about 40 percent of total marine fish catch).

Note: Percentage figures at right represent percent increase (+) or decrease (-) from three-year average in 1960s to three-year average in 1980s.

Sources: CPI and meat prices supplied by Department of Commercial Economics.
Fish prices supplied by MOAC, Department of Fisheries.
Income data from MOAC, Agricultural Statistics of Thailand, Crop Year 1981/82, p. 200.

Domestic demand for pork will continue to grow as population increases and as incomes continue to rise. Foreign demand for exports of Thai pork, however, has been low due to the unhygienic slaughter conditions described earlier. This is unlikely to change unless there is a change in the government regulations which have led to this situation.

These government regulations pose a major impediment to development of the swine industry. Because of the monopsonistic nature of the carcass wholesale trade, pig growers receive small profit margins and sometimes incur loss. There is little incentive, therefore, to expand or improve production. This applies to both small-scale growers and larger commercial operations. Because of these constraints to production, pork prices are likely to continue to rise.

Poultry

The poultry sector is generally the first livestock sector to be developed along modern lines in developing countries. This is because poultry technology is relatively easy to implement, requires less space and capital investment than for other animals, and enables producers to achieve a more rapid turnover and earlier returns. In addition, because of the shorter growing time, the price of chicken relative to the price of ready-mixed feed is higher than the relative price between beef or pork and feed (41). In Thailand, the absence of the kind of government constraints imposed in the hog industry has helped to promote the rapid commercialization of broiler production since the early 1970s; broilers now comprise about 80 percent of all chickens.

Chicken production

Chickens in Thailand were traditionally of native varieties which were allowed to scavenge what food they could from farm wastes and broken rice. Many farm households still maintain five to ten of these hardy indigenous chickens for their meat and eggs. According to the 1978 Agricultural Census, almost 70 percent of all growers held less than twenty chickens (43, p. 443). These growers accounted for only half of total production in that year, however.

Commercial broiler production developed in tandem with the expansion of the animal feed industry. As feed companies began to integrate vertically in order to ensure markets for their feed, they either established their own broiler farms or made contracts with independent growers. (This will be discussed more fully in a later section.) Using technology imported from the U.S., commercial farms

typically raise 10,000-20,000 birds[12] for seven or eight weeks under very strict diet and health supervision. For the same reasons as in hog production, commercial broiler farms are concentrated in the Central Plain provinces near Bangkok. More than 35 percent of all broilers are grown in this region (43, p. 488).

Estimates of annual chicken production from 1970 to 1982 are presented in Table 3.3. In the first column, government figures for chicken population are given. It is unclear exactly what these numbers represent,[13] but in any case they are of little use, for they obviously do not measure yearly production. Because of the impossibility of accurately ascertaining the number of chickens on small farms, the numbers for total chicken production given in the second column should be viewed only as rough estimates. The estimates for 1981 and 1982 were derived from broiler production for those years, using 80 percent as the proportion of total chickens raised as commercial broilers in 1982.[14] A median 73 percent was assumed for the proportion of broilers in 1981 to derive total chicken production for that year. These figures are consistent with 1983 Board of Trade estimates of 300-350 million birds (66, p. 1).

It appears, then, that while total chicken production increased by roughly two and one-half times from 1970 to 1982, the number of native birds and layers (shown in the final column of Table 3.3) decreased by more than half. Since commercial layer production (to be discussed later) actually increased somewhat during this period, this decrease is due to a dramatic drop in the population of indigenous chickens. This has occurred because these chickens are now raised mainly for on-farm consumption; the town markets are now supplied by commercial producers.

Commercial broilers are the important feed consumers in the poultry sector, and the figures given in Table 3.3 for broiler production are probably fairly reliable. Higher estimates are given by the Department of Livestock and Fisheries, but these appear to be too high when compared with mixed feed consumption for these years. (See Appendix Table 5.)

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[12] Nipon (43, p. 488) cites a 600,000-700,000 bird farm as the largest.

[13] They are presumably from an annual survey of some sort, but this is not clearly defined in the government statistical tables. According to an official at the MOAC, these numbers include only small-farm production. An animal scientist at Kasetsart University, however, believed that the figures indicate breeding stock.

[14] Estimates of the proportion of commercial chicken production in the 1980s range from 70 percent to 90 percent (42, p. 98; 51, p. 46; 72). Eighty percent seems a reasonable compromise.

TABLE 3.3

THAILAND: ESTIMATES OF CHICKEN PRODUCTION, 1970-1982

(1000 birds)

Year	Government Estimates[a]	TISC Estimates[b]		Broilers As % of Total Chickens	Native Birds and Layers[d]
		Total Chickens[c]	Broilers		
1970	58,791	136,300			
1971	53,976	150,700			
1972	52,782	166,800			
1973	61,816	182,200			
1974	47,805	190,600	36,400	19	154,200
1975	53,860	198,500	41,600	21	156,900
1976	49,889	206,400	58,200	28	148,200
1977	56,306	211,600	78,000	37	133,600
1978	65,324	216,900	104,000	48	112,900
1979	60,540	222,000	130,000	59	92,000
1980	56,043	301,900[f]	200,000	66	101,900
1981	63,264	320,500[f]	234,000[g]	73	86,500
1982	70,000[e]	357,500[f]	286,000[g]	80	71,500

a. Source: Thailand, MOAC, Agricultural Statistics of Thailand Crop Year 1981/82, p. 95.
b. Source: Thai Investment and Securities Co., Ltd. (1979), cited in Nipon Poapongsakorn, "Factors Affecting Production, Processing, and Marketing of Broilers and Hogs in Thailand," in J.C. Fine and R.G. Lattimore, eds., Livestock in Asia: Issues and Policies (Ottowa, 1982), p. 98.
c. Includes broilers, native birds, and layers.
d. Derived by subtracting broilers from total chickens.
e. FAS/Bangkok estimate.
f. Estimates derived from broiler production.
g. Feed company estimates.

In less than ten years, broiler production rose from 36 million birds (which was less than 20 percent of all chickens) in 1974 to 286 million birds in 1982. This translates into an annual growth rate of 27.3 percent. This prodigious growth, however, appears to be leveling off. Estimates for 1983 from feed company officials and from the DLD range from 234 million to 286 million birds, which are also the estimates given for 1981 and 1982.

Consumption of chicken.

Technological advances in broiler production and economies of scale have resulted in lower production costs and hence lower chicken prices. As can be seen in Figure 3.2, the real price of chicken meat dropped 42 percent from 1967 to 1982. During this time, real fish prices also decreased somewhat, but real beef and pork prices increased; in addition, real income rose 60 percent. These factors have made chicken even more competitive. One would therefore expect chicken consumption to have risen commensurately.

Conversion of the chicken production estimates found in Table 3.3 into per capita meat consumption[15] indicates that this is true. These figures are compared with other consumption estimates in Figure 3.3. Although there is not much historical information, per capita consumption of chicken appears to have risen substantially from the early 1970s to the early 1980s, perhaps as much as threefold. On the other hand, per capita pork consumption, although consistently higher than chicken consumption, does not seem to have increased as much. (See Figure 3.1.) Although estimates differ widely, per capita pork consumption probably doubled at the most during this period.

Linkages with the animal feed industry

Given the abundance of feed ingredients in Thailand, it is not surprising that the commercial animal feed industry has become a major agribusiness, with important backward and forward linkages.[16] The expansion of this industry began in the late 1960s and accelerated in the 1970s. Feed production (presented in Table 3.4) grew more than tenfold in a mere decade, from about 0.1 million tons in 1970 to 1.5 million tons in 1981, an annual growth rate of 23 percent.

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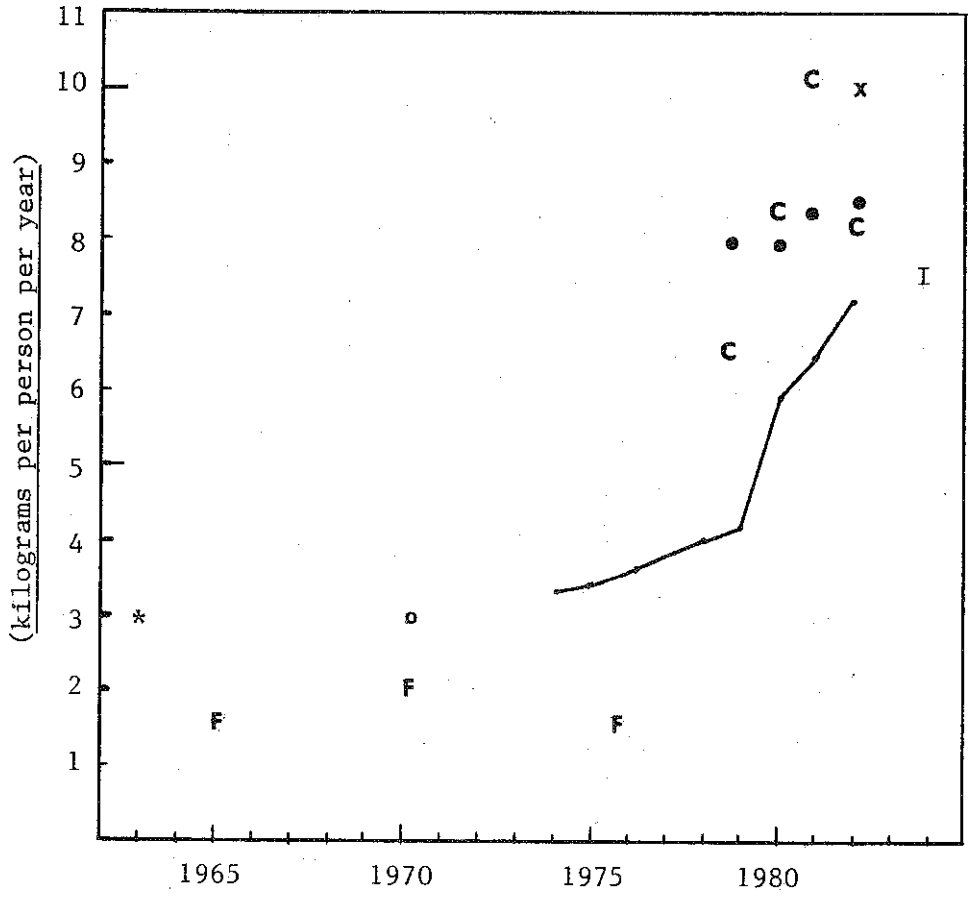
[15] The assumptions entailed in these calculations are explained in Appendix Table 6.

[16] Preecha's thesis (50) is the most comprehensive study of the Thai feed industry to date, and provided much of the information for this section. Nipon (41 and 43) has also conducted research into this area.

Figure 3.3: THAILAND: COMPARISON OF ESTIMATES OF PER CAPITA CHICKEN CONSUMPTION, 1963-1984



— = Derived from Table 3.3. (See Appendix Table 6.)
* = Thai government Household Expenditure Survey (quoted in Asian Livestock, October 1976).
F = FAO estimates (3-year averages) from Food Balance Sheets.
c = Feed company (C.P.) estimates.
x = For Bangkok slum. From Khaisiri Konjing and Madee Veerakitpanich, "Food Consumption and Nutrition in Thailand" in T. Panayotou, ed., Food Policy Analysis in Thailand (Bangkok, 1984 draft), p. 331.
o = For farmers. From Sudhep Indhapanya, "Livestock and Poultry Industry in Thailand" in APO, Livestock Production in Asian Context of Agricultural Diversification (Hong Kong, 1976), p. 325.
o = USDA, FAS Attache Report TH3013, February 18, 1983.
I = Poultry International, May 1984, p. 16.

TABLE 3.4

THAILAND: PRODUCTION AND USAGE OF ANIMAL FEED, 1965-1981

Year	Production[a]	Exports[a]	Exports As % of Production	Domestic Use
	(1000 tons)			(1000 tons)
1965	58	6	10.5	52
1966	60	5	7.9	55
1967	61	4	6.8	57
1968	64	5	7.8	59
1969	111	15	13.9	96
1970	109	0	0.1	109
1971	200	3	1.6	197
1972	266	15	5.6	252
1973	242	9	3.8	233
1974	288	0	0.0	285
1975	487	0	0.1	486
1976	666	16	2.4	650
1977	726	20	2.7	706
1978	923	18	2.0	905
1979	1,174	32	2.7	1,142
1980	1,350[b]	37	2.8	1,313
1981	1,545[b]	41	2.7	1,503

SOURCES:

a. Department of Business Economics, cited by Preecha Pipatkusolsook, "Market Structure, Conduct and Contract Integration: A Case Study of Formula Feed Industry" (Bangkok, 1982), p. 3.

b. Preecha's estimate.

Virtually all of this feed is used within Thailand. Exports of commercially-mixed feed, although growing in absolute terms, decreased as a proportion of production from 10 percent in 1965 to about three percent in the early 1980s.[17]

Feedmills primarily manufacture feeds for hogs and broilers. Smaller amounts of feed for layers and ducks are also produced. This feed composition has changed over the years. As shown in Figure 3.4, swine feed was the largest category in the early 1970s, comprising about half of total production. But as poultry raising became more commercialized, production of poultry feed assumed a dominant position. Chicken feed now accounts for about 70 percent of production. Most of this (70 percent, or almost half of total production) is for broilers; the rest is for layers.

Whereas production of swine feed is divided into both complete feed and concentrate feed (i.e., high-protein feed to be mixed with grain by the farmer), the more exacting dietary needs of broilers require that more poultry feed be complete feed. This means that, as production has shifted from swine feed to poultry feed, a further production shift has occurred from concentrate feed to complete feed. The proportion of complete feed production increased from less than 60 percent of total production in 1971 (41) to nearly 80 percent in the early 1980s (72). This in turn implies an increased need in the feed industry for feed grains in general, and for maize in particular (because of maize's preferred qualities for broilers). Maize now constitutes an average 55-60 percent of commercial feed by weight (8; 34).

A 1974 study of feed industries throughout East and Southeast Asia concluded that their market structures tended toward monopoly or oligopoly as a result of economies of scale (cited in 50, p. 7). This has been the case as well in the Thai industry, with the market for commercial feed becoming increasingly concentrated. Of the 28 feedmills in operation in 1981, the four largest firms captured almost 80 percent of the market share in that year; the C.P. group[18] alone controlled more than 50 percent of the market (50, pp. 17, 67).

The seasonality of the agricultural inputs used by the feed industry provides a strong incentive for firms to integrate vertically, both backward to ensure raw material supply and forward to

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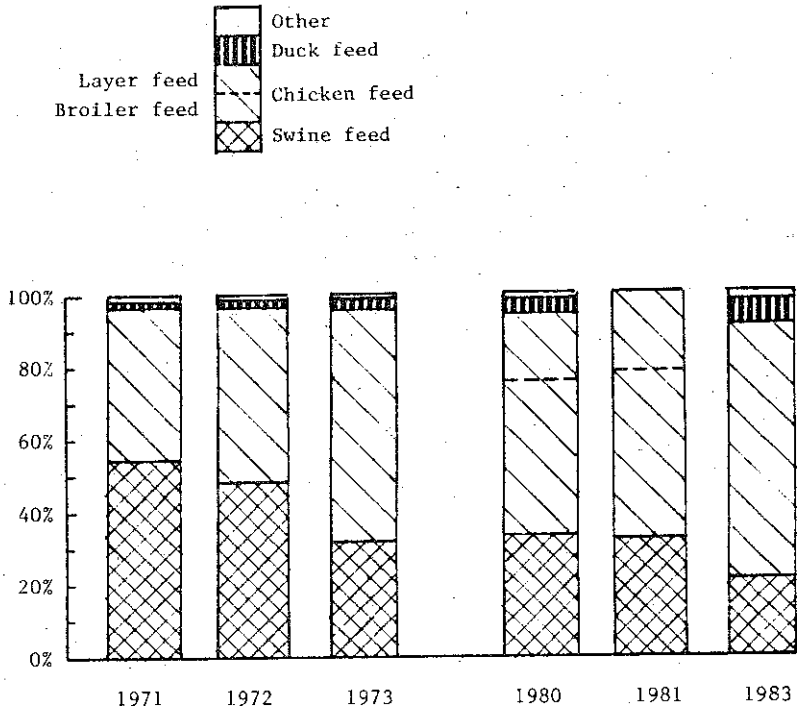
[17] In order to ensure domestic supply, exports of commercial feed have been controlled since 1973. From March 1973 to October 1975, exports were not permitted; since then, exports have been allowed up to ten percent of a firm's production. Actual exports are, however, much lower than this.

[18] The Charoen Pokphand group of companies comprises about 30 firms involved in various agribusiness activities. The six C.P. feedmills have been the dominant enterprise in feed production since 1972 (50, p. 47).

Figure 3.4: THAILAND: PERCENT COMPOSITION OF COMMERCIAL FEED BY CATEGORY OF ANIMAL FED, 1971-1983, SELECTED YEARS



Sources: 1971-1973: NESDB, cited in Nipon Poapongsakorn, The Animal Feed Industry in Thailand (Bangkok, 1981).
1980: Intima Trongtham, "Demand for Corn by Feed Industry in Thailand" (Thammasat University, 1981), p. 37.
1981: Data supplied by MOAC, Department of Livestock Development.
1982: Bangkok Bank Monthly Review, June 1983, p. 270.

ensure demand for their feeds.[19] Vertical integration also serves to reduce costs, as transaction costs at intermediate stages are minimized. Thus, the major Thai feed companies include in their backward linkage operations seed production, grain-redrying and silo facilities, fishmeal manufacturing, and maize and soybean cultivation. Forward linkages in the poultry sector include breeding farms, hatcheries, contracted production of broilers and layers, and chicken processing plants. There has been some expansion as well into hog production and processing, but this has been hindered by the constraints described earlier.

Commercial growers of chicken fall into two primary categories. An independent grower purchases his feed, chicks, and medicines from whichever dealers he chooses, and then sells his broilers directly to a processor or middleman. He thus exerts full managerial and technical control, and assumes all the risks of production and marketing. Because of the risks involved for growers, and because of the desire of feed companies to ensure markets, there is a tendency in most poultry industries toward contract growing. In the U.S., for example, the proportion of integrated broiler producers grew from five percent to 95 percent of all growers in the period 1950-1960 (53, pp. 68-69). In Thailand, based on studies in the Central region (where more than 35 percent of all broilers are grown), contract growers appear to have increased from 70-75 percent of all producers in the late 1970s to more than 90 percent in 1981 (43, pp. 488, 495).

There are four basic types of contracts found in Thai broiler production, each associated with a different incidence of risk to the grower. Under an open account contract, the dealer (the feed company) provides feed, chicks, and medicines on credit. The grower provides the house, equipment, and labor. The full-grown broilers are sold back to the dealer with the cost of supplies deducted. Thus, the dealer assumes all marketing risk, but the grower must bear the burden of production risks, and he can lose money if the broiler price is not high enough to cover the cost of supplies. A variant of this kind of contract is the guaranteed price plan, under which the grower is guaranteed a certain price for the broilers and hence has less risk.

With flat fee, or wage, contracts, the dealer provides the supplies without cost and then pays the grower a flat sum per bird. The grower thus becomes essentially a piece-rate worker for the feed company. In order to provide more management incentive to the grower, combination plans were introduced, under which the grower receives a lower flat fee plus a bonus related to efficiency indices such as feed conversion and mortality rates. In Preecha's 1981 survey of farms in the Central region, he found a distinct increasing trend toward these wage contracts, which accounted for about 55 percent of the 114 farms

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[19] The backward and forward linkage indices of the feed industry were fifth and sixth among 93 manufacturing subsectors, as computed from the 1975 Input-Output Table for Thailand (50, p. 99).

he surveyed, compared with 31 percent for guaranteed price contracts and 3 percent for open account plans (50, p. 111).

Not surprisingly, an oligopolistic market structure also exists in the chicken industry. The C.P. group, for example, controls 40-45 percent of chicken supply and 50 percent of all other stages of production and marketing (43, p. 531). Large firms are usually strongly linked with multi-national corporations, and therefore enjoy advantages in production technology, marketing, and credit availability (41). This trend toward a market dominated by a few large companies is also enhanced by the investment promotion privileges granted to some firms by the Board of Investment (BOI). Industrial promotion certificates were first awarded in the feed industry in 1969. In 1977 the BOI extended these privileges to firms that export processed chicken. These privileges include exemption or reduction in income taxes, import duties, and export and sales taxes. Privileges are only granted, however, to firms with investment worth at least 50 million baht (43).

Exports of chicken

Unlike the swine industry, the poultry industry has not been hampered by constraints imposed by government policies. Private slaughterhouses are allowed, there are no slaughtering fees or permits required, and strict meat inspection is performed by qualified veterinarians from the DLD. Rather than being inhibited, the poultry industry has in fact been encouraged by the government, with the granting of promotional privileges for export in 1977. These favorable conditions have helped Thailand take advantage of a lucrative export market for chicken.

A C.P. subsidiary began exporting frozen chicken in 1973. (See Table 3.5.) These exports rapidly increased to about 33,000 tons in 1982, an annual growth rate of 65 percent. Current exports translate into about ten percent of total broiler production in Thailand. By 1981, chicken exports had become the tenth most valuable agricultural export item in terms of foreign exchange earned. Thailand is also about the tenth largest exporter of poultry in the world, although her exports only account for one or two percent of world trade.

Almost all chicken exports go to Japan, and Thailand has been able to rapidly increase her share in this market. In 1982, imports from Thailand accounted for 32 percent of all Japanese poultry imports. The largest share (generally 55-60 percent) of the Japanese market belongs to the U.S. The U.S., however, exports whole, New York dressed chicken,[20] whereas Thailand exports mainly higher-value, cut-up boneless meat. Although production costs in Thailand are 30

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[20] In New York dressed chickens, only the blood and feathers are removed; heads, feed and viscera remain.

TABLE 3.5

THAILAND: CHICKEN EXPORTS, 1973-1982

Year	Exports		Exports as % of Broilers	% to Japan[a]
	(tons)[a]	(1000 birds)[b]		
1973	135	14	n/a	99.5
1974	337	289	0.1	99.9
1975	373	313	0.1	98.4
1976	2,211	1,858	3.0	99.8
1977	4,254	3,575	4.6	99.6
1978	9,287	7,804	7.5	99.7
1979	14,158	11,898	9.2	99.9
1980	18,503	15,549	7.8	94.2
1981	26,769	22,495	9.6	98.6
1982	33,217	27,913	9.8	96.3

SOURCES:
a. Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.
b. Assume 1.7 kilogram liveweight and 70% meat yield.

percent higher than in the U.S. (43, p. 543), Thailand is able to compete in the Japanese market because of lower transport costs (due to proximity), and because lower labor costs allow more processing.

This fortuitous market situation, however, is not expected to continue. Indeed, Thai exports in 1983 dropped to 24,000 tons, less than the levels in either 1981 or 1982. Japanese demand for chicken is peaking, and at the same time Japanese poultry production is expanding. Japanese imports in 1984 are expected to be less than they were in 1981 or 1982 (48). Coyle (15) gives two alternative projections for imports in 1990 which are down to the 1980 level or lower.

Thailand's continued ability to compete in this declining market is in question. Under U.S. pressure, the Japanese have lowered the tariff on whole chicken, wings, and legs[21], while the tariff on boneless chicken parts is still 20 percent. In addition, advances in automatic cut-up machines will help reduce American processing costs and make chicken parts from the U.S. more competitive (43).

The most likely hope for future poultry exports is the Middle East market. Domestic production there is not keeping pace with rising demand; self-sufficiency in poultry is estimated to be only 63 percent in 1985, down considerably from 79 percent in 1974 (46, p. 44). Thailand's ability to enter this market will depend on how well she can compete with other countries (Brazil, the EEC) which are closer and often subsidize their exports.

Layers and ducks

As the mixed feed industry has expanded and become more vertically integrated, commercial laying operations have also developed. There is little information on the number of commercial layers, but the data on egg production (shown in Table 3.6) seem to be seem to be fairly reliable.[22] The number of layers needed for these levels of egg production are derived by assuming each bird lays 220 eggs per year (19, p. 93). C.P. estimates for both layer population

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[21] The tariff on these parts was 13.8 percent in July 1983 (66, p. 2), and is supposed to be reduced to 10 percent by 1987.

[22] This can be checked by comparing feed production with feed consumption. Assuming that 1.8 kilograms of feed are needed per dozen eggs (44, p. 536), the estimated amounts of feed required in 1980 and 1981 are 297,000 and 315,000 tons, respectively. These numbers are remarkably close to the amounts of layer feed consumed in those years (288,764 and 315,725 tons, respectively), which are estimated by assuming that layer feed comprised 21 percent of domestic feed use (see Figure 3.4).

TABLE 3.6

THAILAND: CHICKEN EGG PRODUCTION AND LAYER POPULATION, 1977-1982

Year	Chicken Egg Production [a]	Layer Population	
		Estimate I[b]	Estimate II[c]
	(1000 dozen)	(1000 birds)	
1977	134,750	7,363	
1978	127,500	6,967	
1979	163,000	8,907	11,300
1980	165,000	9,016	13,100
1981	175,000	9,563	15,200
1982	190,000	10,383	

SOURCES:

a. 1977-78 from Vallentine et al., "Interim Findings: Provisional Draft BOI Programme on the Livestock and Meat Products Sector" (draft, 1981), p. 55.
1979-82 from FAS Attache Report TH3013, February 18, 1983, p. 30.

b. Derived from egg production, assuming 220 eggs per bird per year.

c. Data supplied by Charoen Pokphand.

and egg production are somewhat higher, around 198.1 million dozen in 1981 (12).

Ducks in Thailand are mostly native birds or crossbreeds. There is evidently very little commercial production. The data on duck population, presented in Table 3.7, are inconsistent. Estimates for 1977 alone range from 7.7 million (41) to 20 million (2). If one calculates duck numbers from egg production,[23] a much lower population is indicated. This may mean that production of duck eggs is underreported. In any case, ducks are insignificant in terms of estimating feed consumption. Aside from the small number consuming commercial feed (duck feed is only five to seven percent of current mixed feed production), ducks subsist largely on grasses and insects (28).

Future prospects

The strong growth exhibited by the Thai poultry sector in recent years is not expected to continue at such a fast pace. Domestic chicken consumption is now at one of the highest levels in Southeast Asia[24] and is tapering off. Technology in the poultry industry is now almost equal to that in the West; further advances in efficiency will likely be small. For these reasons, there is little likelihood that the past dramatic decreases in chicken prices, which have helped fuel the expansion in demand, will continue.

Similarly, unless Thailand is able to take advantage of the new markets in the Middle East, exports are unlikely to exhibit much further expansion. Thus, future growth in poultry will most likely be confined to the normal growth generated by increases in population and income.

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[23] Two assumptions are made. First, ducks are assumed to produce 220 eggs per year (19, p. 93). Second, laying ducks are assumed to be 70 percent of the population. This is a compromise between estimates of 60-66 percent (2) and 83 percent (51).

[24] Poultry International estimates per capita chicken consumption in Thailand to be 7.5 kilograms per year. The respective estimates for Malaysia and the Philippines are 10.2 kilograms and 3.8 kilograms; a future target of 1.9 kilograms for Indonesia is given as well (47).

TABLE 3.7

THAILAND: DUCK POPULATION AND EGG PRODUCTION, 1974-1982

Year	Population Estimates				Duck Eggs[e]
	I[a]	II[b]	III[c]	IV[d]	
	(1000 birds)				(1000 dozen)
1974	12,697	7,457			
1975	10,946	7,546			
1976	11,683	7,637			
1977	9,991	7,728		5,709	73,135
1978	9,013	7,821		4,977	63,750
1979	10,196		13,196	6,401	82,000
1980	11,020		13,558	6,635	85,000
1981	13,381		14,000	7,026	90,000
1982	13,000[f]			7,806	100,000

SOURCES:

a. Thailand, MOAC, Agricultural Statistics of Thailand Crop Year 1981/82, p. 95.
b. Bangkok Bank, cited in Nipon Poapongsakorn, The Animal Feed Industry in Thailand (Bangkok, 1981).
c. Data supplied by Charoen Pokphand.
d. Derived from egg production, assuming:
   1) 220 eggs per bird per year.
   2) layers are 70% of chicken population.
e. 1977-78 from Vallentine et al., "Interim Findings: Provisional Draft BOI Programme on the Livestock and Meat Products Sector" (draft, 1981), p. 55.
   1979-82 from FAS Attache Report TH3013, February 18, 1983, p. 30.
f. FAS/Bangkok estimate.

Cattle and Water Buffalo

The predominant livestock in Thailand are water buffalo and cattle. Their populations seem to have been fairly constant in the last fifteen years, with the number of buffalo ranging from about 5.5 to 6 million head and the number of cattle from 4 to 4.6 million head. (See Table 3.8.) These animals are used for draft purposes and are generally slaughtered only when they are too old to work, after eight to twelve years. Bovine animals are included in the Animal Slaughtering and Meat Sale Control Act of 1959, which has had adverse effects similar to those found in the swine sector.[25] Illegal slaughter is estimated to be 70-75 percent of the total (45, p. 20; 80, p. 4), and conditions are not hygienic.

The fact that the number of cattle and buffalo has not increased means that beef production has been stagnant and has not kept pace with the growth in demand stimulated by rising population and income. Demand for beef was estimated in 1982 to be growing at an average rate of five to six percent (54, p. 130). Beef prices have therefore risen more than pork, chicken, or fish prices.[26] (See Figure 3.2.)

In terms of feed use, however, neither cattle nor buffalo are an important consideration here, because the bulk of their feed is obtained by grazing, with supplemental feeding of rice straw in the dry season. The number of dairy cattle, for which nutritionally-balanced feed is important, is small, estimated at 50,000 head (77, p. 19). Milk accounts for a very small part of the Thai diet, and 90 percent or more of the milk products consumed is imported (49, p. 147; 77, p. 19). Despite efforts to increase dairy production,[27] environment and animal health problems make it unlikely that the local dairy industry will expand sufficiently to fill this gap. In addition, milk imports consist mostly of ingredients to reconstitute milk. This recombined milk is cheaper than domestic milk and seems to be preferred to fresh milk by Thai consumers (49). Even if the dairy population were to increase to the size needed to completely supply domestic milk demand, the amount of feed required by these cows would be less than three percent of the total amount of feed now required by the livestock sector in Thailand.[28]

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[25] As is the case with hogs, slaughterhouses must be managed by municipal authorities, and inspection is under the jurisdiction of the Ministry of Interior rather than the DLD. In addition, in order to avoid depletion of draft stock, animals are allowed to be slaughtered only after a certain age.

[26] For more information on bovine animals in Thailand, see Ruangrai and Panayotou (55).

[27] Estimates of dairy cattle numbers for 1978 range from 8000 head (10, p. 15) to 20,000 head (80, p. 50), either one of which implies a sizeable increase in the last six years.

TABLE 3.8

THAILAND: BUFFALO AND CATTLE POPULATIONS, 1967 - 1981

(1000 head)

Year	Buffalo		Cattle	
	Population	Official Slaughter	Population	Official Slaughter
1967	5,462	80	4,177	234
1968	5,550	89	4,290	246
1969	5,642	89	4,452	247
1970	5,735	89	4,667	259
1971	5,574	89	4,460	253
1972	5,361	85	4,485	269
1973	5,546	59	4,093	249
1974	5,642	60	4,150	240
1975	5,597	72	4,142	224
1976	5,895	102	4,322	293
1977	5,827	116	4,341	384
1978	5,959	113	4,437	386
1979	6,028	101	4,276	382
1980	5,650	85	3,938	345
1981	6,124	86	4,469	327

Source: Thailand, MOAC, Agricultural Statistics of Thailand Crop Year 1981/82, pp. 84, 92.

Livestock/Feed Price Ratios

The price relationships between feed and the primary feed consumers in Thailand are shown in Figure 3.5. In each case, the price of a kilogram of livestock was divided by the price of a kilogram of the principal feed consumed by that animal.[29]

The most dramatic change in time has been in the broiler/maize ratio, which fell 42 percent from a 14.9 average in 1970-72 to an 8.7 average in 1980-82. This decline, however, has been balanced by the advances in production technology during these years. Improvements in feeding efficiency, for example, have offset almost half of this decline, for the feed conversion rate (FCR) for broilers decreased 18 percent from 2.55 in 1972 to 2.1 in 1982. (This will be discussed further in the next chapter.) Although less easily quantified, other factors inherent in the commercialization of broiler production (e.g., curtailment of costs due to economies of scale; reduction of risk and transaction costs due to vertical integration) have also contributed to maintaining profitability despite a worsening of the broiler/feed ratio. This does demonstrate, however, the fact that while commercialization of chicken production has occurred to the advantage of Thai consumers, it has been to the detriment of small-scale independent chicken growers. As production has rapidly expanded, relative chicken prices have dropped, to the point that only large-scale operations are able to contain costs sufficiently to be profitable.

The hog/feed (broken rice, in this case) ratio has also declined, although not as dramatically as the broiler/feed ratio. The hog/broken rice ratio decreased 17 percent from a 1970-72 average of 7.0 to a 1980-82 average of 5.8. In contrast to the case of broilers,

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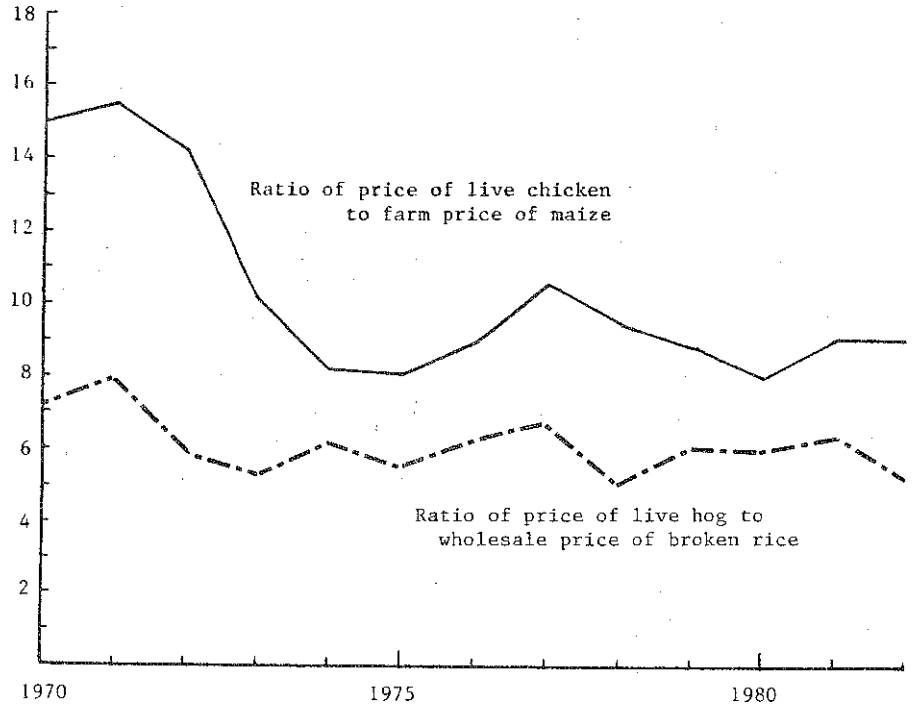
[28] Interpolating from the estimate that 134,000 cows would be needed to supply 1978 milk demand of 245,000 tons of milk (10), we can assume an average 1.83 tons of milk is produced per cow per year. (This converts into 12.4 pounds of milk per cow per day, which is an extremely low level of production, but perhaps not unreasonable given the unfavorable climate and lack of management expertise.) Current milk consumption of 350,000 tons (79, p. 27) would then indicate a required dairy population of 190,000 cows, almost five times the current population. Assuming a cow consumes one kilogram of feed per three kilograms of milk produced (20, p. 43), the 350,000 tons of milk now demanded would, if supplied domestically, imply a requirement of about 115,000 tons of feed. This is only 2.6 percent of the 4.5 million tons of feed now required for all livestock. (See Chapter IV.)

[29] The prices used were all at the farmgate level except for the price of broken rice, for which only wholesale prices were available. Although this lowers the hog/feed price ratio, it should not alter the trend along time, provided the marketing margin between farmgate and wholesale prices has not changed.

Figure 3.5: THAILAND: LIVESTOCK/FEED PRICE RATIOS, 1970-1982



Sources: Broiler, hog, and maize prices supplied by Department of Business Economics.
Broken rice prices supplied by Department of Internal Trade.

however, this decline has not been neutralized much by improvements in production efficiency. Although the FCR of commercially-raised hogs has improved (perhaps by about 15 percent since 1972[30]), these hogs are a minority in the Thai swine population. Similarly, because most hogs are still raised on small farms, producers are not able to enjoy cost reductions due to economies of scale. Therefore, despite rising pork prices, the declining hog/feed ratio helps explain the relative stagnation of the swine sector.

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[30] Prasarn (49) cites an FCR estimate of 3.85 for 1972; the current FCR for hogs of improved breeds is probably between 3.0-3.5.

Chapter IV

DEMAND FOR FEED

Demand for any input is ultimately derived from the demand for the final product and depends upon the particular production function for that product, in which the output is a function of the use of the various inputs. Under the first-order conditions of the production function, the marginal product of each input is equal to the ratio of the price of that input to the price of the output.

Assuming profit maximization, differentiation of the profit equation associated with this production function yields the derived demand function for the input. The use of that input is contingent upon the price of that input, the prices of other inputs, and the price of the output. Inclusion of these prices in the derived demand function reflects the fact that demand for an input depends in essence upon the marginal productivity of that input, i.e., upon the incremental increase in output given a unit increase in input use.

Demand for a particular feed is thus typically viewed as a function of its own price, the price of substitute feeds, and the price of livestock and livestock products. Due to technical aspects of animal feeding, two corollary variables are usually included. First, because feedgrains must be supplemented with protein, the price of protein feed is often considered as important as the price of substitute feeds when estimating grain demand. Second, because livestock population changes over time, the number of animals fed is commonly included. This variable is often expressed in terms of animal units or livestock-production units, which are calculated to include rates of feed consumption. Changes in these feeding rates (i.e., changes in the marginal productivity of feed) are a function of technology and are sometimes included implicitly in the demand equation as a time trend variable. Hence, the basic demand relationship can be expressed as

$$QF_t = f(PF_t; AU_t; PSF_t; PL_t; e_t)$$

where QF_t = quantity of feed fed during year t
PF_t = price of feed in year t
AU_t = number of animals units fed during year t
PS_t = price of substitute or supplement feed in year t
PL_t = price of livestock and livestock products in year t
e_t = stochastic error term.

In the United States, econometric demand analyses of this kind are common. Future demand for feed can be projected by making

assumptions about future prices and livestock numbers. To do this, however, one needs historical data regarding feed consumption, livestock production, and prices for both feed and livestock.

In Thailand, unfortunately, data of this kind do not exist. Although price information can be obtained, feed disappearance can only be estimated on very aggregate levels, as was done in Chapter II. Similarly, feed conversion rates are a matter of conjecture for small-farm livestock production. Intima (34) attempted to estimate demand for maize by the Thai feed industry using a model similar to the one outlined above. But she used as the livestock variable the Ministry of Agriculture numbers for chicken population (see Table 3.3), which are completely unrelated to actual broiler production.

Alternatively, feed demand can be derived from the demand for meat.[1] For purposes of projecting future demand econometrically, a quantity-dependent equation is generally postulated in which the quantity consumed of a particular food item is a function of its price, the prices of substitute foods, and income. Future demand is projected by assuming future prices and income.

Again, however, one needs reliable statistics, in this case on consumption as well as prices and income. In Thailand, as explained in Chapter III, data on meat consumption are very poor. Thus, neither of the econometric approaches to feed demand discussed above can reasonably be applied to the Thai situation.

Methodology Used to Project Feed Demand in Thailand

The approach taken in this paper is to derive feed demand from projected demand for livestock products. This can be done because all the animals which consume feed (excluding forages or items produced on the farm) are ones which are raised specifically for the product they yield. Animals which have other uses (draft cattle and buffalo) consume mainly residual feeds. High and low expected growth rates in population and per capita income, along with high and low estimations of income elasticities, are used to project to 1990 a range of demand for each livestock category. The corresponding demand for feed is then extrapolated using expected feed conversion rates.

Demand for livestock products has two components: domestic demand and demand for exports. Both of these will be influenced by the prices of those products and of their substitutes. The extent of this influence is governed by the price elasticities and cross-elasticities for those products. In the methodology outlined

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[1] This assumes, of course, that the demand for livestock is determined by the demand for food use. This would not be valid in the case of beef in Thailand, which is a residual of crop farming.

above, however, prices are not included. This omission will not be too detrimental to the analysis as long as the relative price ratios remain the same. Although technological change in the Thai poultry industry has caused these price ratios to change dramatically in the past, this will likely be moderated in the future. Technological change in the near future will not be as dramatic in any of the livestock sectors. In chicken production, technology is almost equal to that in the West; and technological advances in pork and beef production are hindered by government regulation.

In this analysis, expansion of domestic demand is determined by growth in population and in per capita income. However, whereas population growth leads to a proportionate increase in demand (assuming that any change in age structure has no effect), income growth leads to an asymmetrical increase which depends upon the income elasticity of that commodity. Thus,

Consumption projected = (base consumption)(demand growth rate)

$$\text{Demand growth rate} = (1 + p)[1 + (y)(e)]$$

where p = proportionate increase in population
y = proportionate increase in per capita income
e = income elasticity.

This method of projecting demand is used by De Boer (20) for feedstuffs in Indonesia and by Dean and Collins (18) for food commodities in the EEC.

Similarly, demand for exports is contingent upon worldwide demand, which depends upon foreign population and income growth rates, as well as upon transport costs. However, exports are important only for broilers and, as discussed in Chapter III, are not expected to grow unless Thailand is able to take advantage of new markets in the Middle East.

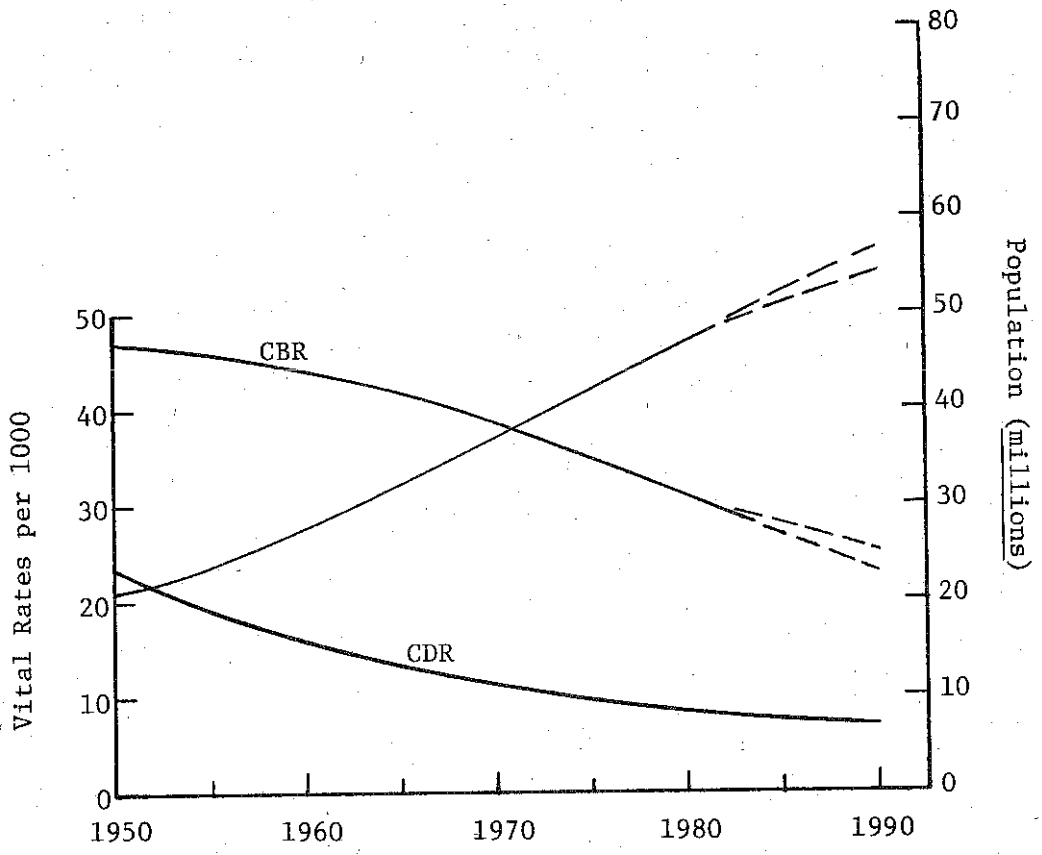
Factors of Demand

Population growth

As in most developing countries, Thailand has had to wrestle with the problems of an expanding population. Unemployment, both rural and urban, has grown, and the push for land has led to severe deforestation and to the emergence of a class of landless laborers. Vigorous efforts by the government in the 1960s and 1970s, however, have succeeded in substantially reducing the population growth rate. From an average rate of 3.1 percent in the 1960s, population growth dropped to an average of 2.4 percent for the period 1970-1982, and it is still decreasing (83).

In Figure 4.1, population growth since 1950 is plotted against its demographic determinants, the crude birth rate and crude death

Figure 4.1: THAILAND: POPULATION GROWTH, CRUDE BIRTH RATE AND CRUDE DEATH RATE 1950-1982, WITH RANGES OF PROJECTIONS TO 1990



Source: Data for 1960-1982 from U.N., World Population Prospects as Assessed in 1980 (New York, 1981).

rate. The notable drop in the crude birth rate during the 1970s is attributable to widespread acceptance of the government's efforts to control population growth.[2]

In its Fifth National Economic and Social Development Plan (for 1982-1986), the NESDB gives 2.1 percent as the population growth rate in 1981, and sets as a goal for 1986 a growth rate of 1.5 percent. The World Bank projects an average annual population growth rate of 1.9 percent for Thailand for the years 1980 to 2000.[3] The NESDB estimates thus seem reasonable extremes for a projected range of future population growth rates. A 2.1 percent growth rate supposes no further progress in controlling population, whereas a 1.5 percent growth rate assumes the government is able to fully meet its goals within a short time.

Income growth

After two decades of rapid growth, Thailand's economic growth rate has slowed down in the past several years. According to the World Bank (83, p. 112), average annual growth in real GDP was 8.4 percent in the period 1960-1970, and 7.2 percent in 1970-1980. In 1982, however, the NESDB estimated that real GDP growth decreased to 4.2 percent. For the period of the Fifth Plan (1982-1986), the NESDB set as its goal a 6.6 percent yearly increase in real GDP. These two estimates, then, define reasonable upper and lower limits for possible future income growth. An annual 4.2 percent rate of increase would entail minimal economic growth, while a 6.6 percent real growth rate implies fairly strong economic expansion for the rest of the decade.

In order for these estimates to reflect growth in real per capita income, the projected population growth rate must be subtracted. Therefore, in the scenario depicting high growth in consumption, a 2.1 percent population growth rate is assumed, and the rate of increase in real per capita income can be derived by subtracting 2.1 percent from 6.6 percent to get 4.5 percent. In the low growth scenario, a 1.5 percent increase in population is assumed, and growth in real per capita income is given by 4.2 percent minus 1.5 percent, or 2.7 percent.

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[2] For example, the proportion of married women of childbearing age using contraception has increased greatly, from 15 percent in 1970 to 59 percent in 1981 (83, p. 256).

[3] Thailand's success in the area of population control is evident when one compares this projection with the Bank's projections for other countries. For example, the Bank predicts a 2.2 percent average growth rate for all middle income countries and a 2.9 percent average growth rate for all low income countries except China and India.

Income elasticities

The degree to which higher income will engender greater consumption depends upon the income elasticity of demand for the particular commodity. Income elasticity is defined as the percent change in consumption given a one percent change in income. Elasticities greater than one denote an increase in consumption disproportionately greater than an increase in income; elasticities less than one indicate that consumption rises less than does income. Lower elasticities generally apply to less desired commodities, and negative elasticities imply inferior goods.

Unfortunately, elasticities are difficult to quantify, and estimates vary widely from study to study, especially when (as in Thailand) consumption levels themselves can only be surmised. Most studies investigating elasticities in Thailand therefore rely on consumption expenditure data. In addition, elasticities are not constant: as income increases, the elasticity will change. Caution must thus be exercised when evaluating the results of the analysis.

With this caveat in mind, various estimates of income elasticities for Thailand are presented in Table 4.2. Elasticities are given for five animal products; the elasticities for rice are included for comparison. Although the specific numbers differ, several basic conclusions can be drawn. First, consumption of all three meats (pork, beef, and chicken) is relatively inelastic, although it is more elastic than rice. Second, the higher elasticity of pork is consistent with the fact that pork is the preferred meat in Thailand. The inferior status of beef, which mostly comes from old, toughened draft animals, can be seen from its low elasticity. The relative position of fish to meat is unclear.

These elasticities are comparable to ones found in the Philippines and Taiwan (also shown in Table 4.2). As in Thailand, the elasticity of rice is very low, and (with the exception of chicken in Taiwan), the elasticities for meat are less than one. The relative elasticities of the different meats in the Philippines are similar to those in Thailand. (The much higher income levels in Taiwan reduce the extent to which income elasticities there can be compared with those in the other two countries.)

The elasticities for Thailand presented in Table 4.2 thus seem to be reasonable approximations for our purposes. Prasarn's estimates are used for the case of high growth in consumption of hogs and broilers, and the FAO estimates are used for the low growth scenario. For eggs, however, only Prasarn gives an income elasticity. (Mann's estimate aggregates eggs with dairy products, and hence is not very useful.) Estimates based on Prasarn's are therefore used in both the high and low growth scenarios for eggs. (Income elasticities for eggs in the Philippines lend some credence to his estimate.)

TABLE 4.2

THAILAND, PHILIPPINES, AND TAIWAN: ESTIMATES OF INCOME ELASTICITIES OF DEMAND FOR LIVESTOCK PRODUCTS, CA. 1975

	Thailand			Philippines				Taiwan	
	Mann[a]	Prasarn[b]	FAO[c]	Dosayla[d]	ASEAN[c]	Kunkel et al.[e]		Wu[f]	Sillers[g]
Pork		.584	.38	.58	.85	.73	.30	.39	.45
Beef	(.498)	.406	.23	.53	.80	.70	.30	.97	.96
Chicken		.437	.27	.56	1.00	.38	.20	1.10	1.07
Fish	2.413	.363	.37	.27	.50	.26	.21	.66	.28
Eggs	(.720)	.480	—	.47	—	.69	.35	.68	.67
Rice	-.024	.125	.05	.04	.22	.06	-.02	-.10	-.42

SOURCES:

a. Jitendar Mann, "Food Demand Pattern in Thailand" (USDA, 1982). Personal consumption expenditure data are used for 1960-1969. Pork, beef and chicken are aggregated, as are milk, cheese and eggs.

b. Prasarn Trairatvorakul, "Food Demand and the Structure of Thai Food System" (Harvard, 1982). Household food expenditure data from 1975/76 survey are used.

c. C. Geissler and D. Miller, "Nutrition and GNP: A Comparison of Problems in Thailand and the Philippines," in Food Policy, August 1982, p. 204.

d. E.D. Dosayla, "A Cross-Section Analysis of Food Consumption in the Philippines" (Cornell, 1979). Cross-sectional data from 1974 survey are used.

e. D.E. Kunkel et al., "Estimates of Demand Elasticities for Selected Agricultural Products in Major Philippine Areas: Manila, Urban and Rural Areas, 1970-1980" in Journal of Agricultural Economics and Development, November 1978. Cross-sectional consumption data are used for 1970-1973.

f. Cited in D.A. Sillers, "Taiwan: An Export Market Profile" (USDA, 1983. Time series and cross-sectional data are used for 1951-1976.

g. Sillers, Ibid., using Wu's data for 1967-1980.

Demand for Feed-Consuming Livestock Projected to 1990

For purposes of feed demand estimation, the animals of interest are hogs, commercial broilers, and layers. The feed required by the dairy industry is negligible; other bovine animals and ducks are mainly fed on residual feeds.

Table 4.3 summarizes the growth assumptions listed in the preceding section and gives the projected demand for these livestock categories in 1990, based upon consumption estimates for 1983. Due to the unreliable nature of consumption and production statistics, the estimates for 1983 are very rough approximations. A slightly arbitrary figure of 6.5 million was chosen for hog consumption, based upon trends evinced in Table 3.1 and upon interviews with feed companies in 1983. Broiler consumption in 1983 was derived by subtracting 10 percent for exports from an assumed production level of 286 million birds.

The calculations involved in projecting consumption for 1990 are shown in Appendix Table 7. Based on the foregoing assumptions, the projected demand for hogs rises 20–40 percent by 1990. The projected demand for chicken, which has a lower income elasticity, increases by a lesser amount, 17–30 percent.

Using the liveweight and meat yield assumptions outlined in the previous chapter, these projections of livestock population can be converted into per capita meat consumption. For hogs, projected demand under high growth implies a per capita pork consumption of 8.7 kilograms; with low growth, per capita consumption would be 7.9 kilograms. Both of these figures are in the range of per capita pork consumption estimates for recent years as calculated from adjusted slaughter and shown in Figure 3.1.

For chicken, the high growth scenario implies 7.0 kilograms per capita consumption. Under the assumptions of low growth, a per capita consumption of 6.6 kilograms is indicated. This suggests that, as mentioned earlier, the trend in chicken consumption displayed in Figure 3.3 will indeed level off or even decrease somewhat. Thus, in the absence of further reduction in the relative prices of these meats, the recent vigorous increases in per capita demand cannot be expected to continue.

The credibility of these projections, of course, rests upon the veracity of the various components of the model. First, the projections are only as good as the 1983 estimates upon which they are based. The estimate for hog consumption, especially, is derived largely by educated conjecture, and the projections drawn from it must be appraised accordingly. Second, the various growth assumptions may be inappropriate. The assumed growth rates for population and income probably represent fairly accurate ranges of future growth. However, there is no way of verifying the income elasticities chosen. Third, the model itself assumes that future prices will have no effect upon consumption. To the extent that price ratios change (if, for example,

TABLE 4.3

THAILAND: DEMAND FOR LIVESTOCK PROJECTED TO 1990

		Population Growth	Per Capita Income Growth	Income Elasticity	1983 Consumption	Consumption Projected to 1990
HOGS	High	2.1%	4.5%	.6	6.5 million	9.1 million
	Low	1.5%	2.7%	.4		7.8 million
BROILERS	High	2.1%	4.5%	.4	257.5 million	337 million
	Low	1.5%	2.7%	.3		302 million
EGGS	High	2.1%	4.5%	.5	200.0 million dozen	270 ml. doz.
	Low	1.5%	2.7%	.4		239 ml. doz.

technology in one sector progresses more than expected), and to the extent that consumption is affected by these changes (which will depend upon the price elasticities of the different commodities), actual consumption levels will differ from these projections.

In addition, it must be remembered that these projections for livestock consumption are based solely on demand factors. Actual consumption will depend ultimately upon production, which will be determined by producers' responses to their economic environment. Clearly, the recent rapid expansion in poultry production is due as much to aggressive measures taken by the feed companies as to consumer demand for chicken. Similarly, there exists a strong demand for pork in Thailand which will be met only if producers are willing to expand operations despite the obstacles imposed by government slaughter regulations. Other external factors, such as government price supports for certain crops or the availability of credit, will no doubt influence producer decisions.

Demand for Feed

Using feed conversion rates, current demand for feed can be calculated for the livestock population estimates given in Chapter III. Future feed demand is then projected for the livestock projections calculated above.

Feed conversion rates

The quantity of feed consumed by an animal in the course of its life depends upon the feed conversion rate (FCR). The FCR is defined as the amount of feed required per unit of output. For example, a 5.0 FCR for swine indicates that 5 kilograms of feed are needed per kilogram liveweight. Thus, a hog with this FCR which is slaughtered at 100 kilograms liveweight will consume 500 kilograms of feed during its life. With improved technology in breeding and in formulating rations, the FCR is reduced and less feed (the major cost item in livestock production) is required.

The FCR of commercially produced hogs in Thailand is generally agreed to be 3.0-3.5. Assuming a 100 kilogram liveweight (this assumption was discussed in Chapter III), 300-350 kilograms of feed per hog is implied. Because of poorer technology in small farm operations, the FCR of swine raised on these farms is much higher; estimates range from 3.5 (12) to 6 or 7 (24, p. 6). An average FCR of 5.0 is cited by Sarote and Jowaman[4] (57, p. 90). This would entail 500 kilograms of feed per hog.

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[4] De Boer (20, p. 43) also uses an FCR of 5.0 for Indonesian pigs.

Assuming that 15 percent of the pigs are fed using commercial technology, an approximate average of 475 kilograms of feed are needed per hog throughout Thailand. The bulk of this feed is energy feed (i.e., feedgrains), predominantly rice products. For hogs produced with more advanced feeding technology, protein feeds constitute 10-20 percent of the rations.

Rapid technological advances in the Thai broiler industry have resulted in a sharp drop in the feeding rates for chickens. The FCR decreased from 3 or 4 in 1965 to 2.55 in 1972, and is now not far from the U.S. average of about 1.9 (44, p. 376). The FCR used here to estimate feed demand is 2.1, which is the FCR cited by C.P. sources (12), and is in the middle ground of various other estimates. For an average 1.8 kilogram broiler liveweight, an FCR of 2.1 translates into 3.8 kilograms of feed needed per bird. Of this ration, 60-70 percent is composed of energy feed (maize or rice bran) and 20-25 percent is protein feed.

In contrast to swine and broilers, layers are not slaughtered as soon as they reach a market weight, but are kept as long as they are productive, for 18 months or more. On the average, each layer consumes 35-40 kilograms of feed per year (12; 44, p. 56; 57, p. 90). However, because more reliable statistics exist on egg production than on layer population, feed consumption is better expressed in terms of egg production. An average of 1.75 kilograms of feed is needed per dozen eggs (19, p. 93; 44, p. 536). Similar to broiler rations, layer rations include about 65 percent energy feed and 15-20 percent protein feed.

Current demand for feed

Current demand for feed in Thailand is derived from the livestock populations estimated in Chapter III. These calculations are summarized and compared with current feed supply in Table 4.4. Feed demand is calculated from estimated livestock numbers for 1983, which are close to estimates for 1982. Feed supply estimates are for 1982/83.

Thailand's abundance of energy feeds can be readily seen from this table, for supply more than meets demand. The low supply figure for protein feed is misleading, for this number only includes fishmeal and soybean meal. Other protein feeds are also used in Thailand (peanut meal, copra, feathermeal, etc.), although in much smaller amounts. Including these feeds would narrow the gap in protein supply indicated in Table 4.4. As described in Chapter II, however, protein feeds do constitute the major constraint in total feed supply, and imports have therefore become more important.

TABLE 4.4

THAILAND: DEMAND AND SUPPLY OF FEED, 1982-1983

	Total Feed	Energy Feed	Protein Feed
		(1000 tons)	
SWINE[a]			
6.5 million head			
x 475 kilograms feed per hog	3,088	2,995	69
BROILERS[b]			
286 million birds			
x 3.8 kilograms feed per bird	1,087	706	245
LAYERS[c]			
200 million dozen eggs			
x 1.75 kilograms feed per dozen eggs	350	228	61
TOTAL FEED REQUIRED 1983	4,525	3,929	375
FEED SUPPLY 1982/83		4,274[d]	255[e]

a. Assumes 85% consume only energy feed, 15% consume ration of 80% energy feed/15% protein feed.
b. Assumes broilers consume 65% energy feed/22.5% protein feed.
c. Assumes layers consume 65% energy feed/17.5% protein feed.
d. Rice products and maize for cropyear 1982/83. (See Table 2.8.)
e. Fishmeal and soybean meal for 1982. (See Appendix Tables 2 and 3.)

Demand for feed projected to 1990

The high and low estimates for feed demand projected to 1990 are shown in Table 4.5. It is assumed that feed conversion rates will not change much. Because of the constraints inhibiting commercial expansion of hog production, it is doubtful that the FCR for pigs will decline in the near future. Continued technological advancement in broiler production may further reduce broiler FCRs, although not by much. The projections for the low growth scenario take into account a possible reduction of the broiler FCR to 1.9 from the current 2.1.

Because much further penetration by the commercial feed industry into hog and broiler production is unlikely, the proportions of energy and protein feeds will remain about the same. Demand for energy feed (rice products and maize) at the end of the decade, then, can be expected to be from 15 percent to 36 percent greater than in 1983. Demand for protein feed, on the other hand, will display slower growth; the amount of protein feed required will increase by three percent to 25 percent by 1990. This is because, ceteris paribus, the higher income elasticity of pork means that demand for hogs will increase more than the demand for chicken or eggs. Protein feed is not an important part of the diet for most Thai hogs, few of which are raised on modern formulated rations.

This assumes, however, that technology in these sectors will not change. If more swine come to be raised in commercial operations, or if the price of chicken continues to drop and demand for chicken expands in response, the amount of protein feed required in the future will be greater than indicated in Table 4.5.

The low and high projections for energy feed demand in 1990 are shown in Figure 4.2, along with the past growth in supply of rice products and maize. With a large increase in demand for livestock products, the increase in demand for energy feeds will be similar to the growth in supply experienced in the past decade. A low growth in demand, on the other hand, will entail a levelling out of the current trend.

It is impossible to predict the relative proportions of these feed ingredients that are likely to be used to meet this demand. The projected 15-36 percent demand growth would entail an average yearly increase of 2-5 percent. The supply of rice products increased at an average annual rate of about 3 percent from 1970 to 1982. If this growth continues at this same moderate pace, a large growth in feed demand will necessitate further increases in the domestic use of maize.

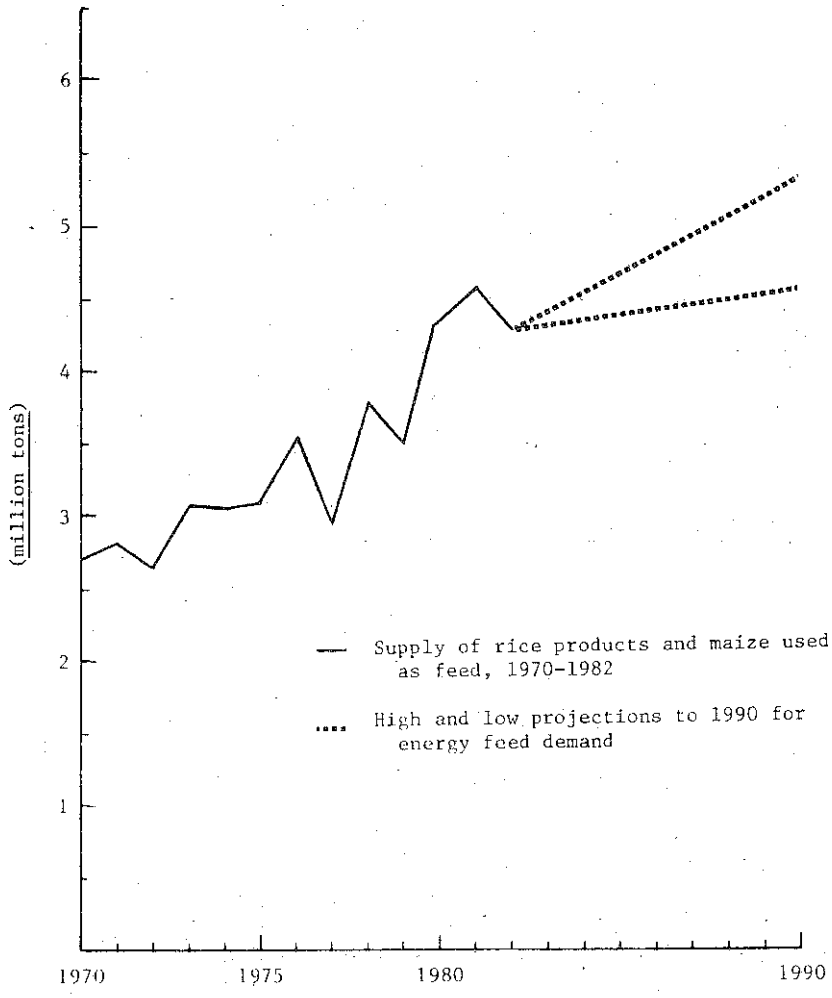
TABLE 4.5

THAILAND: DEMAND FOR FEED PROJECTED TO 1990

Projected Livestock Consumption[a]		Energy Feed		Protein Feed	
High	Low	High	Low	High	Low
		(1000 tons)		(1000 tons)	
HOGS					
9.1 million	7.8 million	4,193	3,594	97	83
BROILERS					
337 million	302 million	832	671[b]	288	232[b]
EGGS					
270 ml. doz.	239 ml. doz.	307	272	83	73
TOTAL		5,332	4,537	468	388

a. From Table 4.4.
b. Assumes, in addition to the general assumptions outlined for the low growth scenario, that the feed conversion rate declines to 1.9 by 1990.

Figure 4.2: THAILAND: DEMAND FOR FEED PROJECTED TO 1990



Chapter V

CONCLUSIONS AND POLICY IMPLICATIONS

The development and growth of the commercial broiler industry has benefitted Thailand by lowering consumer prices for chicken meat and by garnering foreign exchange for value-added exports. However, this industry will probably not develop a great deal more in the future: further technological advances will be marginal, and large expansion (both export and domestic) is questionable.

The short-term prospects for the swine industry do not look promising, due to institutional constraints. If regulations were changed, however, there is potential for development similar to that of the broiler industry.

To fully take advantage of the growth potential of the feed-livestock sector, several government policies would need to be changed.

1. The single most important obstacle to livestock production is the Animal Slaughtering and Meat Sale Control Act of 1959, which is primarily responsible for the stagnant trend in swine production.[1] The taxes imposed on slaughtered animals encourage illegal slaughtering; the restrictions placed upon private ownership of slaughterhouses limit incentives for improving facilities; the prohibition of carcass transport across the boundaries of trading areas impedes competitive trading; and the inadequate inspection provided by the Ministry of Interior fosters unhygienic conditions. Amendment of these regulations would help promote expansion in both small-farm and commercial hog production. This might also facilitate an export trade in Thai pork meat.
2. There is much potential for expansion of rice and maize production by intensive means. Among the policies needed to bring about such changes are improvement and expansion of irrigation; increased production and improved distribution of high-yielding seeds[2] and less restrictive pricing policies and improved distribution of fertilizer.

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[1] This law also governs slaughter of ruminant animals.

[2] The constraint of inadequate seed supply has shown recent improvement, as feed companies have become involved in seed production to help ensure raw material supply.

3. The biggest constraint to feed supply is the inadequate production of protein sources. The reliance upon imported protein feeds is the result of high domestic fishmeal prices relative to soybean meal prices, and insufficient supply of domestic soybean meal. Furthermore, domestic meal is of poorer quality and costs more than imported meals. In addition to the policies listed above to improve crop yields, policies aimed at increasing soybean meal production would include establishment of a guaranteed minimum price scheme;[3] development of varieties with higher protein content;[4] and establishment of tax incentives to encourage modernization of the oil extraction industry.

In the absence of such targeted policies, Thailand should have no difficulty in meeting even a large increase in domestic demand for energy feed ingredients. There exists a large surplus of maize which is now exported but could be used within the country. There is also much scope for production increases of both rice and maize. However, assuming relative price ratios between fishmeal and soybean meal do not change, the preference for soybean meal means that the supply of protein feeds will likely continue to be dependent upon imports.

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[3] A 1977 MOAC study (cited in 49, p. 248) found Thai soybean production to be highly responsive to price incentives.

[4] This, however, may conflict with efforts to improve the oil content of soybeans.

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Appendix

APPENDIX TABLES

APPENDIX TABLE 1

THAILAND: TRADE IN RICE BRAN, 1971-1981

(tons)

Year	Imports	Exports			Net Trade in Rice Bran[b]
	Bran	Bran	Bran Cake = Bran Equivalent[a]		
1971	122	—	—	—	+ 122
1972	128	—	33,735	40,645	-40,517
1973	233	—	9,207	11,093	-10,861
1974	88	—	79	95	- 7
1975	102	112	—	—	- 10
1976	—	716	8,183	9,860	-10,575
1977	—	591	5,706	6,875	- 7,466
1978	—	851	18	22	- 873
1979	1	1634	6,029	7,264	- 8,897
1980	—	546	3,500	4,217	- 4,763
1981	—	506	943	1,137	- 1,643

a. Based on rice bran = 17% oil.
b. Positive sign indicates net imports.
Negative sign indicates net exports.

Source: Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.

APPENDIX TABLE 2

THAILAND: FISHMEAL SUPPLY AND UTILIZATION, 1970-1982

(tons)

Year	Domestic Production[a]	Exports[a]	Imports[b]	Total Domestic Consumption	% of Production Used Domestically
1970	63,685	13,215	541	51,011	79
1971	60,922	18,339	354	42,937	70
1972	73,176	28,194	453	45,435	61
1973	91,774	24,325	207	67,656	73
1974	94,717	21,946	4	72,775	77
1975	94,980	26,919	2499	70,560	72
1976	119,880	49,083	200	70,997	59
1977	134,304	75,617	0	58,687	44
1978	197,165	111,878	95	85,382	43
1979	194,590	128,469	0	66,121	34
1980	201,190	114,343	466	87,313	43
1981	185,095	113,821	191	71,465	39
1982[c]	175,840	110,000	0	65,840	37

SOURCES:

a. Thailand, MOAC, Department of Fisheries, Fishery Situation, 1983 (in Thai).

b. Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.

c. Department of Fisheries estimates.

APPENDIX TABLE 3

THAILAND: SOYBEAN MEAL SUPPLY, 1970-1982

(tons)

Year	Domestic Production[a]	Exports[a]	Imports[b]	Total Domestic Consumption	Imports as % of Domestic Consumption
1970	21,513	4724	1016	17,805	6
1971	21,569	1208	316	20,677	2
1972	24,122	129	787	24,780	3
1973	27,200	5230	7	21,977	0
1974	37,512	0	2681	40,193	7
1975	39,746	0	8606	48,352	18
1976	41,045	165	9897	50,777	19
1977	43,901	0	53,559	97,461	55
1978	43,118	0	82,357	125,475	66
1979	56,961	48	58,563	115,476	51
1980	48,790	100	154,782	203,472	76
1981	35,858	300	142,997	178,555	80
1982	49,697	250	203,420	252,867	80

SOURCES:

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b. Thailand, Department of Customs, Foreign Trade Statistics of Thailand, various issues.

APPENDIX TABLE 4

THAILAND: NUMBER OF ELEPHANTS, HORSES, MULES AND ASSES, 1967-1981

(head)

Year	Elephants	Horses	Mules and Asses
1967	11,276	174,392	1,250
1968	11,149	173,209	1,282
1969	11,022	172,025	1,312
1970	n/a	n/a	n/a
1971	9,665	118,392	n/a
1972	8,438	62,129	n/a
1973	6,645	51,024	1,457
1974	4,161	23,615	622
1975	4,437	35,405	278
1976	5,208	25,027	2,509
1977	6,629	48,002	8,041
1978	6,311	32,784	556
1979	5,843	31,314	501
1980	4,874	30,880	511
1981	3,705	20,606	164

Source: Thailand, MOAC, Agricultural Statistics of Thailand, Crop Year 1981/82, p. 84.

APPENDIX TABLE 5

THAILAND: COMPARISON OF BROILER ESTIMATES, 1977-1981

Year	Broilers		Feed Required[a]		Feed Consumption	
	from Table 3.3	from MOAC[b]	Table 3.3 Broilers	MOAC Broilers	Total[c]	Broiler[d]
	(million birds)		(1000 tons)		(1000 tons)	
1977	78	159	312	636	706	423
1978	104	187	416	747	905	543
1979	130	185	520	739	1142	685
1980	200	365	800	1459	1313	788
1981	234	340	936	1360	1503	902

a. Assumes each broiler requires 4 kilograms to reach 1.8 kilogram liveweight.
b. Derived from monthly parent and grandparent stock imports. From Thailand, MOAC, Division of Livestock and Fisheries, Agricultural Business 5 (in Thai).
c. From Preecha Pipatkusolsook, "Market Structure, Conduct and Contract Integration: A Case Study of Formula Feed Industry" (Thammasat Univ., 1982).
d. Assumes broiler feed equals 60% of total feed production (interpolated from various estimates in other years).

APPENDIX TABLE 6

THAILAND: DERIVATION OF PER CAPITA CHICKEN CONSUMPTION, 1974-1982

Year	Native Birds	= Meat[a]	Broilers	= Meat[b]
	(1000 birds)	(tons)	(1000 birds)	(tons)
1974	154,200	92,520	36,400	43,316
1975	156,900	94,140	41,600	49,504
1976	148,200	88,920	58,200	69,258
1977	133,600	80,160	78,000	92,820
1978	112,900	67,740	104,000	123,760
1979	92,000	55,200	130,000	154,700
1980	101,900	61,140	200,000	238,000
1981	86,500	51,900	234,000	278,460
1982	71,500	42,900	286,000	340,340

Year	Total Meat	Domestic Consumption[c]	Population	Per Capita Consumption
	(tons)		(1000 people)	(kilograms)
1974	135,836	135,499	40,780	3.3
1975	143,644	143,271	41,870	3.3
1976	158,178	155,967	42,960	3.6
1977	172,980	168,726	44,040	3.8
1978	191,500	182,213	45,100	4.0
1979	209,900	195,742	46,114	4.2
1980	299,140	280,637	47,220	5.9
1981	330,360	303,591	47,488	6.4
1982	383,240	350,403	48,490	7.2

a. The population of native birds includes male birds, which are slaughtered when they reach a market weight (probably less than 1.7 kilograms), and females, which are kept for two or more years as layers until slaughtered (probably at 2.5 kilograms or more). An arbitrary assumption was made that one-half of the population is slaughtered each year. It was further assumed that slaughter weight was a median 2 kilograms, and that meat yield was 60% (USDA, "Conversion Factors and Weights and Measures," p. 26).

b. For broilers, a 1.7 kilogram liveweight was assumed (feed company estimates). Meat yield was assumed to be 70% (USDA, Ibid., p. 26).
c. Total meat production minus exports (given in Table 3.5). This subtraction is valid since Thai chicken exports are mostly boneless meat.

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